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MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.

C. S. WILKINSON, F.G.S., &c., GEOLOGICAL SURVEYOR-IN-CHARGE.

PALÆONTOLOGY, No. 5.

R. ETHERIDGE, JNR., PALÆONTOLOGIST.

A MONOGRAPH

OF THE

CARBONIFEROUS AND PERMO-CARBONIFEROUS INVERTEBRATA

OF

NEW SOUTH WALES.

PART I.—CŒLENTERATA.

AUSTRALIAN MUSEUM SYDNEY NEW SOUTH WALES

BY

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Letter of Transmittal.

Department of Mines,
Geological Survey Branch,
4 February, 1891.

Sir,

I have the honor to transmit the accompanying Memoir, No. 5, of the *Palæontological Series* of the Geological Survey of New South Wales, on the *Carboniferous and Permo-Carboniferous Invertebrata of New South Wales:* Part I, *Cœlenterata*, by Mr. Robert Etheridge, Junr., Palæontologist.

The Palæontology of the coal-bearing formations of New South Wales is a subject of much importance, not only from a purely scientific aspect, but also as bearing upon the economic development of the greatest of the mineral resources of the Colony—Coal. It is with this object in view that the attention of the Palæontologist has been primarily devoted to the subject.

Previous palæontological researches in this direction were largely based upon the fossils collected by the late Rev. W. B. Clarke, M.A., F.R.S. The descriptions given in this Memoir are chiefly of specimens in the collections recently made by the Officers of the Geological Survey, and now in the Mining and Geological Museum. These Departmental Collections are of special value for reference, not only because the Clarke Collections have been lost in the Garden Palace fire, but also as illustrating the life-history of the coal formations in the Hunter River District, the survey of which Mr. T. W. E. David, B.A., F.G.S., Geological Surveyor, is at present engaged upon.

It is interesting to note that the Class Actinozoa herein described by Mr. Etheridge shows a remarkable diminution in the Carboniferous and Permo-Carboniferous times, as compared with its high state of development in the Siluro-Devonian Period. This may be due to the physical changes which took place at the close of the latter period in this portion of the globe, and of which we have evidence in the deposition of a considerable thickness of arenaceous beds upon the massive Siluro-Devonian coralline limestones of

our western districts, as near Molong. Moreover, the almost entire absence of any forms of coral life from the Lower Marine Series may, as suggested by Mr. David, have been due to the enormous development of tuffs in the Rhacopteris and Lepidodendron beds which form the upper portion of the preceding formation. Then, again, though the occurrence of striated boulders in the conglomerates of the Upper Marine Series points to deposition in which ice action has been concerned, the comparative abundance of certain genera of corals in several horizons in the Series is evidence of the sea at the time having been comparatively warm, and is opposed to any theory as to a general refrigeration of the Antarctic Ocean in this part of the Permo-Carboniferous Period.

The accompanying table of classification of the different series of the Permo-Carboniferous must to some extent be considered as provisional, and thus indicates how large a field awaits systematic geological survey and palæontological investigation.

I have the honour to be,
Sir,
Your obedient servant,
C. S. WILKINSON,
Geological Surveyor-in-Charge.

HARRIE WOOD, ESQ., J.P.,
Under Secretary for Mines.

Author's Preface.

The present Part is the first of a Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales, contained in the Mining and Geological Museum of the Department of Mines, Sydney. It includes the whole of the Cœlenterata at present existing therein, but a few additional specimens have been obtained from outside sources, and will be suitably acknowledged later on. It is intended to issue the succeeding Parts as time and the state of the Collection will permit.

In the preparation of the descriptions I have frequently taken advantage of the valuable local knowledge and assistance of my colleagues, Mr. C. S. Wilkinson, L.S., &c., the Geological Surveyor-in-Charge, and Mr. T. W. Edgeworth David, B.A., Geological Surveyor.

To Mr. John Waterhouse, M.A., Inspector of Schools, I am under great obligations for the kind manner in which he has always striven to advance the objects of this work, by unreservedly placing his Collection at my disposal, and information at all times kindly supplied.

The Corals herein described have been obtained under the direction of Mr. C. S. Wilkinson, partly by Mr. Charles Cullen, Collector to the Geological Survey, and partly under the supervision of Mr. T. W. E. David, whose Geological Survey of the Maitland District embraces some of the particular coral-bearing beds described in this Memoir; but thanks are also due to the Rev. W. H. Yarrington, M.A., Dr. Morson, Mr. S. Dodds, and Mr. D. A. Porter, for specimens given or lent; whilst the section-cutting has been satisfactorily performed by Mr. Charles Murton, of the Geological Branch. I have also derived great assistance from a collection of Tasmanian *Stenoporæ*, partly collected by Mr. W. Anderson, Geological Surveyor, and partly supplied by my friend Mr. R. M. Johnson, Government Statist of Tasmania. To my colleague Mr. G. H. Barrow, of the Australian Museum, I am greatly indebted for the patience and skill displayed in the preparation of the original drawings, from which the plates have been heliotyped at the Government Printing Office by Mr. A. E. Dyer, under the direction of the Government Printer.

R. ETHERIDGE, Jnr.

Sydney, March, 1891.

I.—INTRODUCTION.

The Fossils described in the present Monograph are those from the marine beds of the Carboniferous and Permo-Carboniferous rocks of N. S. Wales, the former lying below and separated by an unconformity from the latter, which are intercalated with the productive Coal-Measures. The distribution and general features of these strata will be described and their relations discussed in a forthcoming Memoir[1] by Mr. T. W. Edgeworth David, B.A.; but, with the view of rendering the stratigraphical value of the fossils in question as apparent as possible, a generalised classification of the above rocks will be found a few pages on. The Invertebrate Palæontology of the beds lying unconformably above the productive Coal-Measures has already been published.[2]

Four systematic descriptions of New South Wales fossils, coming within the scope of the present work, have already appeared, by Messrs. Morris and Lonsdale, M'Coy, Dana, and De Koninck, respectively. To the late Prof. John Morris and William Lonsdale belongs the honour of first systematically describing the Permo-Carboniferous and Coal-Measure fossils of New South Wales—those collected by the veteran explorer of Tasmania and Gippsland, Count Paul E. de Strzelecki, &c., who in 1845 published his "Physical Description of N. S. Wales,"[3] a work which may be described as the stepping-stone to Australian Geology. Prof. M'Coy's Memoir, published in the year 1847,[4] was a description of the earliest collections of the late Rev. W. B. Clarke, M.A., F.R.S., and generally bore out in a marked degree the conclusions arrived at by Morris. The third collection described was that made by the venerable Prof. James Dwight Dana, when acting as Naturalist and Geologist to the United States Exploring Expedition under Commander Charles Wilkes, U.S.N., between the years 1838–1842. The fossils in question are described in the magnificent volume of the expeditionary series devoted to its geological results.[5] The last series of organic remains referred to were described by the late Prof. Guillaume Laurient de Koninck, M.D., &c., in the "Mémoires de l'Académie Royale de Belgique"[6]; and again

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[1] Geology of the Maitland District, with special reference to the Coal-Measures, 4to. (in preparation).

[2] "The Invertebrate Fauna of the Hawkesbury-Wianamatta Series, &c.," pp. 21, 2 plates, Mem. Geol. Survey, N. S. Wales, Pal. Series, No. 1, (4to. Sydney, 1888). By R. Etheridge, jun.

[3] Physical Description of New South Wales and Van Diemen's Land, accompanied by a Geological map, sections, and diagrams, and Figures of the Organic Remains, pp. 462, plates, &c. (8vo. London, 1845). By P. E. de Strzelecki.

[4] "On the Fossil Botany and Zoology of the Rocks associated with the Coal of Australia," Ann. Mag. Nat. Hist., 1847, XX, pp. 145–157, 226–236, 298–312, Pls. 9–17.

[5] United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U.S.N., Vol. X, Geology, by J. D. Dana, pp. 756, Atlas, Pls. 21 (4to. and folio, Philadelphia, 1849.)

[6] "Recherches sur les Fossiles paléozoïques de la Nouvelles Galles du Sud (Australie)," pp. 373 and Atlas. Mém. Acad. R. Belgique (8vo. and 4to., Bruxelles, 1876–77).

to the exertions and liberality of the late Mr. Clarke we are indebted for the appearance of this great advance in the Science of Palæontology in N. S. Wales. Most of the Strzeleckian fossils described by Morris and Lonsdale are now in the Natural History Museum, London; the original collection made by Mr. Clarke, and described by M'Coy, is deposited in the Woodwardian Museum, Cambridge, England; Dana's gatherings, procured during the Wilkes' Expedition, were placed in the Smithsonian Institution, Washington, and subsequently burnt[1] some years ago; whilst the most complete series of the whole, the second Clarke Collection, was, as is well known, destroyed in the Garden Palace fire in Sydney, in 1882. From this it will be seen that we do not possess in N. S. Wales, nor in Australia for the matter of that, either of the old Collections, containing the original types on which the larger portion of our Palæozoic Palæontological nomenclature depends. This is most unfortunate, more especially as regards the series described by De Koninck, for so many of the species were diagnosed on single, and in some cases imperfect examples, that it is now very difficult to recognize them. Besides the collections here particularised, there have been, of course, from time to time, small sets of fossils described in occasional communications to learned Societies, which need not be further referred to at present; but before closing this Introduction, it may be well to mention the few fossils described by J. de Carle Sowerby in Mitchell's "Three Expeditions into the Interior of Eastern Australia,"[2] and collected by that Explorer at the outset of his First Expedition in the Hunter River District. These are now deposited in the cabinets of the Geological Society of London.

From the above circumstances, it is intended, in this and succeeding Parts, to describe only those species which come directly under the Author's notice as a portion of the Departmental Collection in the Mining and Geological Museum, or as contributed by private Collectors in illustration of the subject, leaving all others described by previous Writers, and not represented, to testify for themselves. With the view of doing every justice to the series described by Prof. de Koninck, a translation of his "Recherches," as literal as possible, will shortly be published as one of the Memoirs of the Geological Survey.

The general geological subdivisions of the Carboniferous and Permo-Carboniferous rocks of N. S. Wales, as at present understood by the Geological Survey, are as follows :—

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[1] I was so informed by Prof. J. D. Dana.

[2] Three Expeditions into the Interior of Eastern Australia, with Descriptions of the recently-explored Region of Australia Felix and the present Colony of New South Wales, I, p. 15. (2 vols., 8vo., London, 1838.)

The Carboniferous and Permo-Carboniferous Formations of N. S. Wales.

		Hunter River Coal-field.	Illawarra Coal-field.	Blue Mountain and Lithgow Coal-field.	Mittagong Coal-field.	Gunnedah or Namoi Coal-field.
PERMO-CARBONIFEROUS.	Upper Coal-Measures	*Newcastle Group.* Productive Coal-Measures, with *Glossopteris*, &c.	*Bulli Group.** ditto	*Lithgow Group.** ditto	*Mittagong Group.** ditto	*Namoi Group.** ditto
		Dempsey Group. Barren fresh-water beds.	(Unproven.)	(Unproven.)	(Unproven.)	(Unproven.)
	Middle Coal-Measures	*Tomago, or East Maitland Group.* Productive Coal-Measures, with *Glossopteris*, &c.	(Unproven.)	(Unproven.)	(Unproven.)	(Unproven.)
	Upper Marine Series	1. Mulbring beds. 2. Muree Rock. 3. Branxton beds, with erratics.	1. Encrinital Shales. 2. Nowra Grit. 3. Conjola beds.	Wallerawang beds.		
	Lower Coal-Measures	*Greta Group.* Productive Coal-Measures, with *Glossopteris, Vertebraria*, &c.	*Clyde Group.* ditto	(Hidden by overlap.)	(Hidden by overlap.)	(Hidden by overlap.)
	Lower Marine Series ...	*Farley Group.*	(Unproven.)	(Unproven.)	(Unproven.)	(Unproven.)
		Unconformity?	*ditto*	*ditto*	*ditto*	*ditto?*
CARBONIFEROUS ...		1. Rhacopteris beds. 2. Marine beds, with *Productus, Conularia*, &c. 3. Rhacopteris and Lepidodendron beds.	(Unproven.)	Rhacopteris and Lepidodendron beds.	(Unproven.)	Lepidodendron beds of Goonoo Goonoo.
		.....	.....	*Unconformity?*	.....	.....
DEVONIAN		.....	.....	Mt. Lambie Sandstones and Quartzite.	.....	.....
SILURIAN		.....	Yalwal Slates.	.....	Marulan Limestone.	.....

* This classification is provisional: the Group may have to be classed with the Middle Coal-Measures.

The classification formerly adopted by various authors was the subdivision of our New South Wales rocks immediately above the Devonian into Lower Carboniferous, Carboniferous, and Permian; or simply Carboniferous and Permian. Recent palæontological investigations will probably lead to a modification of this classification, in so far that the whole of the beds below the Lower Marine Series may be regarded as more truly allied to the Carboniferous simply. On the other hand, that series and the beds above, viz., the Upper Marine and the whole of the Coal-Measures, having an affinity with both Permian and Carboniferous, might be termed the Permo-Carboniferous. The facts in detail, for the support of this view, are still under consideration, and not sufficiently matured for publication, but they appear to tend in the direction indicated. At the same time great caution must be exercised in assimilating our geological subdivisions strictly with those of the old world.

It is impossible, in the following pages, to minutely define the distribution of our uppermost Palæozoic Coral-fauna, simply from our want of knowledge regarding the horizons yielding corals at several localities, such as in the Paterson, Williams, and Rouchel Brook Districts. Mr. C. S. Wilkinson informs me that these are probably localities within the Carboniferous area, or as it would have been termed formerly the Lower Carboniferous. Presuming this to be the case, then we have here the first development of coral life above the Devonian, and it was a moderately copious one. In the Lower Marine Series, however, there would appear to be, so far as our present knowledge enables us to judge, a very considerable falling off, but in the Upper Marine Series corals again make their appearance, comprising several very interesting forms.

II.—DESCRIPTION OF THE GENERA AND SPECIES.

Sub-kingdom—CŒLENTERATA.

Class—ACTINOZOA.

Obs.—One of the most remarkable features in connection with the Permo-Carboniferous Fauna of New South Wales is the great numerical and specific development attained by certain groups of animal life, to the marked, although not total exclusion of others. In no class is this more apparent than the present. In extra-Australian areas, more particularly Europe, side by side with a teeming Molluscan life, a moderately prevalent Crustacean, and a vigorous development of Echinodermata, we find the remains of an equally prevalent Coral fauna during the Carboniferous.

On the other hand, during an equivalent period in New South Wales, and indeed throughout Australia generally, the Actinozoa dwindled to a comparatively insignificant factor. That this was not the case in Præ-Carboniferous times is quite apparent, as a glance at the rich Coral fauna of the Silurian and Siluro-Devonian rocks of this Province will show.

Should future researches support this view, we can only adopt the conclusion that coral life at this particular period, in what is now New South Wales, was gradually dwindling, as it also did during the closing epoch of the Palæozoic Period in other quarters of the globe.

The remains of corals, even when recorded, have been but indifferently preserved and scanty in numbers. This seems to hold good in all cases, except those of the genera *Stenopora*, representing the Monticuliporidæ, and

Zaphrentis, indicating the great group of the Rugosa. At a few localities they have been met with, not in specific abundance, but in a plenitude of individuals. Equally does this statement hold good for the Permo-Carboniferous of Queensland, and I believe for Tasmania also. So little is, however, known of the fossiliferous contents of the thick limestones of Western Australia that such a generalisation cannot be applied to that Province at present.

A glance at the results attained by the four principal workers in the Palæozoic Palæontology of Eastern Australia, during the forty-five years which have elapsed since Lonsdale wrote, will impress this question strongly on the mind of the reader. Lonsdale,[1] in 1844, described the new genus *Stenopora* and four species from New South Wales and Tasmania, afterwards recapitulating these, and adding a rugose coral, *Amplexus arundinaceus*.[2] The last named and two of the foregoing species of *Stenopora* were quoted by M'Coy[3] in 1847, and three other corals added, one being a new genus and species, *Cladochonus tenuicollis*. Passing on to the researches of Dana, we find that he merely localised Lonsdale's *Stenopora* and added a fifth species, but under the name of *Chætetes gracilis*.[4] Lastly we come to the work of the late Prof. L. G. de Koninck, by whom the collections of the late Rev. W. B. Clarke were classified and described. De Koninck,[5] as well as reviewing many of those already referred to, added thirteen species to the Australian Permo-Carboniferous Coral Fauna, appertaining to seven genera, not previously described as coming from that horizon. Omitting one of De Koninck's species (*Lithostrotion basaltiforme*) from the Murrumbidgee,[6] the total gives us nine genera and twenty-one species recorded during the long period in question, but the species may be reduced to twenty by the elimination of one of Prof. M'Coy's, viz., *Turbinolopsis bina*, probably determined on the internal cast of a Zaphrentoid coral. Of the genera, two were specially established for the reception of their species.

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[1] Darwin's Geol. Obs. Volc. Islands, 1844, p. 161, note.

[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 262.

[3] "On the Fossil Botany and Zoology of the Rocks associated with the Coal of Australia," Ann. Mag. Nat. Hist., 1847, XX, pp. 226 and 227.

[4] United States Exploring Expedition, during the years 1838–42, under the command of Charles Wilkes, U.S.N. Vol. X, 1849, Geology by J. D. Dana, p. 712 (4to. and folio, N. York, 1849).

[5] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 143.

[6] There are no Permo-Carboniferous rocks on this river. The coral in question occurs in the Cave Limestone, at Cave Flat, on the Murrumbidgee, south-west of Bowning, and it is questionable if it be a *Lithostrotion* at all. The Cave Limestone is either Upper Silurian or Siluro-Devonian.

Order—ZOANTHARIA.

Sub-order—**Z. Sclerodermata.**

Section A—RUGOSA.

Group—ZAPHRENTOIDEA.

Family—*ZAPHRENTIDÆ.*

Obs.—The late Prof. de Koninck described one doubtful species of *Zaphrentis* as *Z. Phillipsi*, Ed. and H.,[1] and a *Lophophyllum*, *L. minutum*,[2] which have not come under my notice. The *Zaphrentis* may possibly be identical with a species I have later on called *Z. Culleni.*

As *Strombodes? australis*, Prof. M'Coy described[3] a coral in 1847 having some points in common with genera placed in this family. He says it is without transverse chambers (? tabulæ), and the septa twisted about the centre are grouped in irregular bundles. The appearance presented by his figure is certainly that of a Zaphrentoid coral, and this is borne out by the grouping of the septa, but the twisting of the latter, unless it be in a loose and irregular manner, and the absence of tabulæ do not assist in bearing out this supposition. Through some unaccountable error I formerly referred[3] this coral to *Lonsdaleia*, a mistake I now wish to correct.

Genus—AMPLEXUS, *J. Sowerby.*

(Min. Con. I, p. 165.)

AMPLEXUS, *sp. ind.*

Pl. IX, Fig. 10.

Obs.—It will be shown below that the fossil usually known under the name of *Amplexus arundinaceus*, Lonsd., does not appertain to that genus, but a small and apparently undoubted species does exist in our Carboniferous Series (Pl. IX, Fig. 10). The specimen is unfortunately too imperfect for

[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 149.
[2] *Ibid*, p. 147, t. 5, f. 5.
[3] Cat. Austr. Foss., 1878, p. 37.

detailed description, but it is evident that the septa were short, after the type of the genus, and about twenty in number; the tabulæ close, about half a line apart; and the corallum conical and curved at the base.

Locality and Horizon.—Pallal[1] ($\frac{3}{4}$ mile S.W. of), Horton River, Co. Murchison (*C. Cullen*) :—Carboniferous.

Genus—ZAPHRENTIS, *Rafinesque and Clifford*, 1820.

(Ann. Sci. Phys. Bruxelles, V, p. 234.)

Obs.—Dr. G. J. Hinde has recently described a genus of West Australian corals from the Carboniferous as *Plerophyllum*,[2] to take the place of De Koninck's *Pentaphyllum*, previously occupied. The essential characters of his genus are,—(1) the extra-development of four or five prominent septa; (2) the infilling of the interlocular spaces and centre of the corallum with successive layers of stereoplasma; and (3) the presence of a thick outer wall consisting apparently of the coalesced parietal margins of the septa with an outer epithecal layer. The second and third characters are highly developed in our N. S. Wales Zaphrentoid corals, and could I have satisfied myself of the preponderance of four or five septa over the others, in the manner shown in Dr. Hinde's figures, I should unhesitatingly have adopted his genus; but such does not appear to be the case, although there is, as explained in the specific descriptions, an undoubted grouping of the septa, usually into four bundles. In the meantime, I shall content myself by publishing our species with the additional name of *Plerophyllum*, placed after that of *Zaphrentis*, with the view of drawing attention to their close affinity to the latter. On the other hand, if our species are distinct from the absence of these specialised septa, and equally separated from Zaphrentis by the stereoplasmic deposit (well shown in our Pl. VIII, Figs. 7 and 16), which appears to completely fill the lower portions of the corallum with solid tissue, they may, perhaps, in the future be known under the name of *Hemizaphrentis*. This heavy deposit of stereoplasma to some extent allies the present corals to *Lindströmia*, Nicholson and Thomson,[3] in which "the lower portion of the visceral chamber (is) often more or less completely filled up by the deposition within it of solid

[1] This locality was described by the late Samuel Stutchbury in his "Tenth Tri-monthly Report on the Geological and Mineralogical Survey of N. S. Wales" (N. S. Wales Leg. Council Papers, 1853, No. 235 A, pp. 9—Sydney, fcap., 1853), p. 6, and wherein he gave a list of about thirty species of fossils found there. The horizon is at present doubtful.

[2] Geol. Mag., 1890, VII, p, 195.

[3] Proc. R. Soc. Edinb., 1876, IX, No. 95, p. 149.

sclerenchyma."[1] On the other hand, *Lindströmia* possesses a pseudo-columella of peculiar structure, but no septal fossula, and is therefore clearly distinct from the present forms.

Zaphrentis (Plerophyllum?) arundinaceus, *Lonsdale, sp.*

Pl. VIII, Figs. 1 and 2; Pl. IX, Figs. 11–13.

Amplexus arundinaceus, Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 267, t. 8, f. 1.

" " De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 149.

Sp. Char.—Corallum long, cylindro-conical,[2] oval in section. Septa thirty-six, in the calice longer on the dorsal side, curving but little, moderately thick towards the periphery, uniting sub-centrally to form a large septal fossula on the ventral side, coated with stereoplasma; dissepiments very scanty and quite marginal, in one or two cycles; septal fossula large, but not deep, containing one counter septum. Tabulæ well marked, nearly flat or slightly convex upwards, the septa ill-defined thereon, and extending about one-third across; fossula small and shallow, represented on the under surface of each tabulum by a small elongated projection. Epithecal characters unknown.[3]

Obs.—The above description includes certain corals believed to be Lonsdale's *Amplexus arundinaceus*, but his imperfect description must obviously leave the question open to doubt. This might be solved by an appeal to the type now in the Geological Department, Natural History Museum, London, but if my memory does not deceive me this is not in too good a state of preservation either. The late Prof. de Koninck suggested the removal of this species to the genus *Zaphrentis*, a proposition now adopted, and to which he was probably led by the following passage in Lonsdale's remarks:—"Converging radii were traced from nearly half the periphery of the oval across more than two-thirds of the area." In *Amplexus* the septa are usually little more than mere marginal crenulations, but the remarkable manner in which they are developed in the calice of the present species renders its transfer to *Zaphrentis* necessary. Lonsdale's observation that the "crenulations near the margins of the septa or diaphragms were unequal in

[1] Nicholson and Etheridge, Junr., Mon. Sil. Foss. Girvan in Ayrshire, 1888, Fas. 1, p. 80.
[2] De Koninck says more or less curved at the base.
[3] Lonsdale describes the exterior as longitudinally ribbed, and transversely annulated, and is supported in this statement by De Koninck.

range as well as strength, and in some cases they were scarcely detectable," clearly refers to the septa on the tabulated portions of the corallum, and not in the calice, the structure of these two portions of the coral differing considerably, as will be seen from the specific description given above.

I am under the impression that Lonsdale's figure represents a specimen inverted, the apparent tabular boss being in fact the downwardly projecting septal fossula, similar to that represented in our Pl. VIII, Fig. 2, and Pl. IX, Fig. 13. Its excentric position bears this out.

Locality[1] *and Horizon.*—Jervis Bay, Shoalhaven District, Co. St. Vincent (*C. Cullen*); Shoalhaven Heads, ditto (*C. Cullen*) :—**Upper Marine Group.**

Zaphrentis (Plerophyllum ?) cainodon, *De Koninck.*

Pl. VIII, Figs. 13–16.

Zaphrentis cainodon, De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 151, t. 5, f. 8, 8*a*.

Sp. Char.—Corallum cylindro-conical, long, rather curved, gradually tapering, and of somewhat irregular habit from unequal growth accretions, pointed at the base; section generally oval. Calice deep, open. Septa forty to forty-two in number, thickened by a deposition of stereoplasma, which unites to form a coalesced mass on the dorsal side; dorsal septa slightly shorter and straighter than the ventro-lateral, which are curved, and unite in two groups to surround a septal fossula, which reaches to the centre of the calice, and contains from one to three counter septa of variable length; cardinal septum not apparent; dissepiments moderately well developed on the ventral side, and generally irregular in their arrangement; dissepimental vesicles, some oval, some triangular, but usually irregularly developed. Tabulate area small, tabulæ immediately below the calice vesicular. Rugæ appear to be simple both on dorsal and ventral sides; epitheca not preserved, but probably thin.[2]

Obs.—This species generally resembles the next to be described, *Z. gregoriana*, but is much longer and proportionately larger, the calice rounder in section, and the relative increase in diameter within a given space much less. Lastly, the septa are more numerous, and the septal fossula shorter.

[1] Other localities recorded are—Barber's, Barber's Creek, and Amprier, near Glenrock, Co. Argyle (*Strzelecki*); Shoalhaven District (*Strzelecki*); Curradulla, or Limestone Creek, ? Co. Argyle (*M'Coy, Ann. Mag. Nat. Hist.*, 1847, XX, p. 228); Colocolo (*De Koninck*).

[2] De Koninck describes the epitheca as probably thin and smooth.

Z. cainodon is the longest of the smaller species of our *Zaphrentis*, one example measuring three and a half inches in length.

The form of this coral is decidedly more Amplexiform than it is Zaphrentoid; but the convergence of the septa to the centre and presence of dissepimental tissue indicate its generic affinities. The primordial laminæ of the septa are always distinct in the specimens which I have examined, although surrounded by much stereoplasma. The latter, on the dorsal side, at a short distance below the bottom of the calice, becomes fused into a consolidated mass, interseptal loculi being only visible on the ventral side of the corallum, and even then not many of them. This dense deposit of stereoplasma is well seen in a vertical section of the corallum (Pl. VIII, Fig. 16) taken from immediately below the calice of the individual specimen, and to some extent recalls the filling up of the corallum base in *Lindströmia*,[1] Nicholson and Thomson. The vesicular condition of the tabulæ immediately below the floor of the calice is also apparent.

Locality[2] *and Horizon.*—Jervis Bay, Co. St. Vincent (*C. Cullen*):—**Upper Marine Group.**

Zaphrentis (Plerophyllum?) gregoriana, *De Koninck.*

Pl. VIII, Figs. 3-12; Pl. IX, Figs. 8 and 9?

Zaphrentis Gregoriana, De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 150 t. 5, f. 7.

Sp. Char.—Corallum of medium size, more or less cornute, but the curvature never great; section circular; base sharply pointed. Calice moderately deep. Septa thirty-six to thirty-eight, thickened at their proximal or basal ends by the deposition of stereoplasma, which unites to form a coalesced mass on the dorsal side, but the primordial septa remain distinct; the ventro-lateral groups curve upwards and inwards to surround a large septal fossula, which extends just to the centre of the calice, occupied by one or two counter septa; cardinal septum not apparent; dissepiments but little developed[3]; interseptal loculi elongated triangular spaces. Tabulate

[1] See Nicholson and Etheridge, Mon. Sil. Foss. Girvan in Ayrshire, 1878, Fas. I, p. 84, f. 4.
[2] De Koninck records this species from Burragood on the Paterson River.
[3] De Koninck says that the septa are united by irregular vesicles, especially in the outer part of the corallum, but I have not observed these.

area well marked but not large, diminishing much in size towards the base. Rugæ generally single on the dorsal side, bifurcate on the ventral; epitheca not preserved, but probably very thin; growth accretions present, but slight.

Obs.—De Koninck compared this species to *Zaphrentis cliffordana*, Ed. & H.; but it differs from the latter by the arrangement of the rugæ, and is much larger. The dissimilarity of the costæ on the ventral and dorsal sides distinguishes this species from most of the other Australian species. The want of resemblance to *Z. cainodon* is at once apparent; but those specimens which I have examined present a general similarity in the grouping of the septa.

In connection with this species some very interesting internal casts and external impressions may be referred to, especially as the number of septa and their grouping, form of the corallum, and position of the septal fossula are identical with those of *Z. gregoriana*. Both in the impression (Pl. IX, Fig. 9) and matrix surrounding the casts (Pl. IX, Fig. 8) the epitheca is seen to be pierced by a number of irregularly-arranged holes, varying in number and contiguity to one another in different specimens, although in some examples more closely set towards the upper portions of the corallum. These clearly represent epithecal out-growths, such as are met with in some species of *Zaphrentis*, *Amplexus*, &c. It is equally clear that the epitheca in these corals was thick, with moderately strong accretion swellings. On the other hand, we lack definite information as to the epithecal characters of *Z. gregoriana*, and the relation between these casts and the latter must, therefore, remain for the present unsolved.

In Pl. VIII, Fig. 7, is visible one of those peculiar processes springing from the floor of the calice, which have been so abundantly and excellently figured by Rudolph Ludwig in his Memoir, "Corallen aus paläolithischen Formationen," in figures of *Zaphrentis* and other genera, especially one termed by him *Cyathodactylia*.[1]

Locality[2] *and Horizon.*—Jervis Bay, Co. St. Vincent (*C. Cullen*): Upper Marine Group. The spinose casts are from Shoalhaven Heads and Copper Point, Shoalhaven River, Co. St. Vincent (*C. Cullen*):—Upper Marine Group.

[1] Palæontographica, XIV, Heft 4, t. 36 1b, 2b.
[2] De Koninck also mentions Colocolo

Zaphrentis (Plerophyllum?) Culleni, *sp. nov.*

Pl. IX, Figs. 1–7.

Sp. Char.—Corallum small, slender, and cornute in a greater or less degree, sometimes slightly turbinate; base sharp and pointed, at times slightly constricted and the extremity becoming appendage-like; growth accretions numerous at irregular distances apart, and sometimes ill-defined. Calice deep, circular; mouth probably horizontal, or strictly at right angles to the growth. Septa twenty-two to twenty-four, primary and secondary, the former large and passing to the centre, where they become lost on a small tabulum, the latter thorn-like, short, and peripheral; stereoplasma greatly developed; dissepiments apparently absent; fossula not distinguishable. Rugæ fine and regular, but to some extent obliterated by the regular epitheca, which is thick and concentrically striate.

Obs.—This little coral is very characteristic of the Rouchel Brook beds, and appears to be undescribed so far as Australian species are concerned. It is named after Mr. Charles Cullen, Collector to the Geological Survey, as an acknowledgment of his services in collecting material for the elaboration of this Memoir.

The form of the corallum in *Z. Culleni* varies from gently cornute to nearly straight, but one extreme case has been observed where the curvature of the corallum was acute (Pl. IX, Fig. 1). The base is always sharp, rendered so usually by a sudden diminution in size of the corallum, imparting to the base a minutely petiolate or appendage-like appearance. There is a well-marked epitheca which more or less obliterates the sharpness of the costæ. A considerable development of stereoplasma takes place around each septum individually, but on one side of the corallum this is much greater than the other, tending to obliterate many of the remaining features of the calice. Dissepiments appear to be wholly wanting, although loculi are left between the stereoplasmically-thickened septa; nor have I been able to detect a fossula with certainty.

The late Prof. de Koninck referred a single small coral from Colocolo to the well-known European species *Zaphrentis Phillipsi*, Ed. and H., with some doubt. The number of septa described in this specimen totally forbids its reference to the European form, and there is the possibility of its identity

with the present species, *Z. Culleni*. I should have been inclined to refer the Colocolo coral to the latter had it not been for De Koninck's pointed reference to a fossula and grouping of the septa. On the latter hand, however, it may be remarked that a tendency to a grouping has come under my notice in more than one example of *Z. Culleni*, but the extensive development of stereoplasma has so far tended to obliterate structure that too much stress cannot be placed on this point.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*) :—Horizon doubtful, but perhaps Carboniferous. Pallal Station, Horton River, Co. Murchison (*C. Cullen*) :—Horizon ditto. Torryburn, Logan's Station, twelve miles from Parteson, Co. Durham (*Rev. W. H. Yarrington, M.A., and J. Waterhouse, M.A.*) :—Horizon ditto.

Zaphrentis (Plerophyllum ?) robusta, *De Koninck.*

Plate X, Figs 1–3.

Zaphrentis robusta, De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 152, t. 5 f. 9, 9*a*.

Sp. Char.—Corallum moderately large, turbinate, but little curved, and robust, with ill-defined growth accretions; proper wall very thick; section circular; base sharply pointed in the young state, obtuse when older. Calice wide and very deep, nearly equal to half the height of the corallum, the margin horizontal. Septa forty-five, slightly curving on their inward course, not extending to the centre, which is tabulate, except at the base, divided into four groups, the two dorsal containing nine in each, the ventral seven; counter septa two; cardinal septum strong, extending to the dorsal edge of the fossula; alar septa strong and obliquely curved; stereoplasma not highly developed; fossula pyriform, ventral, at the base extending to the centre; dissepiments small, and not numerous; interseptal loculi as long oval-pyriform spaces. Tabulate area moderately large, flat. Rugæ simple, obtuse, and inconspicuous. Epitheca strong and thick, forming short imbricating frills over the rugæ.

Obs.—According to the late Prof. de Koninck this is distinguished from all the preceding species by its turbinate form, large proportional diameter of its calice, and thickness of the epitheca, features I am able to confirm after

an examination of some specimens collected by Dr. Morson and Mr. J. Waterhouse, M.A., in the Maitland District. To these may be added the arrangement of the septa, and the fact that the peripheral edge of the calice is horizontal.

The corallum is, generally speaking, straight, and only curved, to any great extent, at its immediate base. The epitheca is thick and dense, and covers the costæ in concentric laminar frills. The present examples exceed those described by De Koninck in size—one being two and a quarter inches in height, by one and a quarter in breadth across the calice, and another one and three-quarter inches in height, with a greatest diameter of one and a half inches. Our examples possess forty-five septa, De Koninck only quoted thirty-six, but I nevertheless feel satisfied that the forms are the same species, they otherwise so closely correspond.

Locality[1] *and Horizon.*—Branxton, on the Hunter River, Co. Northumberland (— *Morson, M.D.*). Near Dee's Hotel, West Maitland, Co. Northumberland (*J. Waterhouse, M.A.*) :—**Upper Marine Group.**

Zaphrentis phymatodes,[2] *sp. nov.*

Plate IX, Figs. 14–17.

Sp. Char.—Corallum of medium size, turbinate-conical, very slightly curved, with inconspicuous growth accretions; section circular; base slightly curved. Septa forty-eight, irregularly grouped in bundles, which meet at, and become lost on, a small central tabulate area; stereoplasma largely developed, forming a solid peripheral zone, extending inwards for from one-third to half the diameter of the corallum, and afterwards enclosing each septum, leaving between them elongate and irregular interseptal loculi; dissepiments not apparent; fossula lateral[3]; alar septum short. Tabulate area small. Rugæ hid by the epitheca, which is strong, thick, and corrugated, with very numerous tubular out-growths over the whole corallum, and roughly arranged in quincunx.

Obs.—Z. phymatodes is a peculiar species, both in its septal and epithecal characters. On the ventral, or side of the least curvature of the corallum, the septa are united in irregular bundles. The peripheral mass of

[1] De Koninck mentions Burragood.
[2] Φωματώδης, abounding in tubercles.
[3] *i.e.*, on the left-hand side of the observer.

stereoplasma forms a more or less solid zone, but in the space between it and the tabulæ the septa are separate, and there are long irregular loculi. I am unable to distinguish any definite dorsal or ventral fossula, but there is a left lateral one containing a short and rather stout alar septum.

As regards the epithecal characters, a spinose or tubercled epitheca is not unknown in the Zaphrentidæ, but in the present instance this structure of the exoskeleton is developed to a greater extent than usual. It is also more common in *Amplexus* and its allies than in *Zaphrentis*. For instance, spines exist in *Amplexus spinosus*, De Koninck[1], and are confined to the base of the corallum; and in *A. lacrymosus*, De Koninck[2], where they are generally scattered over the surface. Other corals also possess these structures, such as *Axophyllum radicatum*, De Koninck[3], and *Pentaphyllum armatum*, De Koninck[4], from the European Carboniferous. We also possess an Australian species, already described, furnished with similar excrescences, and there is *Amplexus pustulosus*, Hudleston[5], from the neighbourhood of the Gascoyne River, Western Australia. Of the species cited, however, the greatest resemblance exists between *Axophyllum radicatum* and our species. In the latter these out-growths are tubular, but broken off short, and have every appearance of having been used as anchoring stolons.

It may be conjectured that *Z. phymatodes* is related to the spinous form described under *Z. gregoriana*, but the dissimilarity in the number of the septa and position of the fossula will at once dispel any pre-conceived view of this matter. I believe the two corals to be quite distinct.

Locality and Horizon.—One mile south-east of Mulbring, near West Maitland, Co. Northumberland (*C. Cullen*):—Upper Marine Group.

Zaphrentis ? sumphuens[6], *sp. nov.*

Plate XI, Figs. 4–6.

Sp. Char.—Corallum of medium size, conical, curved. Septa forty-four, with an equal number of secondary lamellæ; the primary septa are long, flexuous, reaching nearly to the centre of the corallum, and grouped in

[1] Nouv. Rech. Anim. Foss. Terr. Carb. Belgique, 1872, Pt. I, p. 75, t. 6, f. 6.
[2] *Loc. cit.*, p. 76, t. 6, f. 7.
[3] *Loc. cit.*, p. 24, t. 1, f. 3.
[4] *Loc. cit.*, p. 59, t. 4, f. 8.
[5] Quart. Journ. Geol. Soc., 1883, XXXIX, t. 23, f. 1–1c.
[6] *συμφύω* to make coalesce.

four principal bundles, two dorsal and two ventral; in the centre of the corallum certain of the principal septa meander and coalesce to enclose a series of large open vesicles; an outer narrow, but well-marked, vesicular zone exists, beyond which the secondary septa do not proceed, and in which the primary septa are not enveloped in stereoplasma; dissepiments fine and fairly regular; stereoplasma thickly enveloping the septa from the margin of the outer vesicular zone to the edge of the central vesicles; loculi in the outer zone more or less rhomboidal, when confined by stereoplasma very long and narrow, following the curve of the septa; fossula indistinctly marked, but apparently lateral, with one secondary alar septum.

Obs.—The septa in this species are very irregularly grouped, but there would appear to be four chief sets. The coalescing of the bundles by means of six or seven of the primary septa is very marked, and results in the enclosure of several large vesicles or spaces filled with clear calcite. One of these septa, possibly corresponding to the ventral counter septum, passes directly across the centre, uniting with another which may represent the cardinal septum. I have not observed any trace of a tabulate area. The loculi confined between the septa when thickened with stereoplasma are particularly long and narrow, and at times subdivided by very minute dissepiments at long intervals apart. The section of this coral resembles in many ways that of *Z. patula*, Michelin, as figured by Thomson[1], more particularly as regards the central vesicular space.

Locality and Horizon.—Somerton, near Tamworth, Co. Parry (*D. A. Porter*):—Horizon doubtful, but in the Upper Marine Series.

Genus—LOPHOPHYLLUM, *Edwards and Haime*, 1850.

(Mon. Brit. Foss. Corals, Introd., 1850, p. lxvi.)

Obs.—Two species of *Lophophyllum* were described by Prof. De Koninck as existing in the Clarke Collection. One of these, *L. minutum*, De Kon.[2], has not come under my notice; the other, *L. corniculum*, or at any-rate a coral believed to be it, is described below.

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[1] Corals of the Carboniferous System of Scotland, 1883, t. 6, f. 12, 12*a*.
[2] Foss. Pal. Nouv. Galles du Sud 1877, Pt. 3, p. 147, t. 5, f. 5.

Lophophyllum corniculum, *De Koninck?*

Plate X, Figs. 7–9.

Lophophyllum corniculum, De Koninck, Foss. Pal. Nouv. Galles du Sud, Pt. 3, 1877, p. 148, t. 5, f. 6, *a* and *b*.

Sp. Char.—Corallum of medium size, conical, slightly curved, with fine-growth swellings; section circular; base pointed. Calice deep, with erect margins. Septa thirty-four to thirty-six, alternating with an equal number of secondary lamellæ; primary septa gently bent on themselves dorsally, straight ventrally, converging inwards towards, but not reaching the spurious columella; cardinal septum lamellar along its outer two-thirds, enlarging at its inner extremity in the centre of the calice, into a more or less lanceolate body; below the floor the dorsal, central, and probably ventral septa meet the thickened end referred to, and unite with it to assist in forming the so-called columella; counter and alar septa not diferentiated; fossula dorsal, very large and deep; dissepiments scanty and irregular, forming one or two cycles close to the periphery; vesicles irregular; loculi otherwise open and deep. Epithica thin with fine accretion marks, and delicately concentrically lined; rugæ fine, corresponding to the interseptal loculi.

Obs.—The specimens referred to this species depart from De Koninck's description in the position of the fossula, which is certainly dorsal, or on the side of the greatest curvature of the corallum, and not lateral, or variable. The remaining characters, however, are identical. De Koninck stated that in the corals examined by him the position of the fossula did not correspond to either of the curvatures of the corallum, but was situated sometimes to the right, at others to the left. In *Lophophyllum* the position of the fossula is generally described by authors as ventral, but in their original definition of the genus, Edwards and Haime do not lay down any special rule, and it may therefore vary in position generically, just as much as in *Zaphrentis*.

The position now assigned by writers to *Lophophyllum* is fully borne out by the structure of the Australian specimens. It was shown by Kunth[1] that the supposed columella is only the enlarged inner end of one of the principal septa, usually the counter septum, and not a columella in the true

[1] "Beiträge zur Kenntniss fossiler Korallen," Zeitsch. Deutsch. Geol. Gesellschaft, 1869, p. 193.

sense of the word. This is clearly shown in Kunth's figures of *Lophophyllum confertum*[1] and *L. leontodon*[2]. In the coral now under description, which is far larger than most of the European, the cardinal septum, towards the floor of the calice, expands into a thickened lanceolate body, towards which the dorsal septa converge, curving on themselves (Pl. X, Fig. 9). Still nearer the floor of the calice, the whole of the dorsal septa and some of the lateral unite with this body, which is much enlarged thereby; its connection with the cardinal septum is, however, still traceable. Below the calice floor, and near the base, the whole of the septa unite in the centre, and there seems to be a deposit of stereoplasma.

The secondary septa in our specimens (Pl. X, Fig. 8) are very apparent, although Prof. H. A. Nicholson says that "a division into alternately long and short septa cannot be recognised."[3] This separation is also shown in Kunth's figure of *L. confertum*.

According to De Koninck, *L. corniculum* bears some resemblance to the European *L. Koninckı*, Ed. & H., but is distinguished by the number of its septa, size, and other characters.

Locality[4] *and Horizon.*—Dungog Road, nineteen miles from West Maitland, Parish of Barford, Co. Durham (*J. Waterhouse, M.A.*); Greenhills, near ditto (*C. Cullen*):—Mirari Limestone, Carboniferous.

Genus.—CAMPOPHYLLUM, *Edwards and Haime*, 1850.

(Mon. Brit. Foss. Corals, Introd., 1850, p. lxviii.).

Campophyllum columnare, *sp. nov.*

Pl. IX, Figs. 18–20.

Sp. Char.—Corallum of medium size, straight, cylindrical or columnar with marked accretion swellings; section circular. Septa sixty, with an equal number of secondary lamellæ; the primary septa extend inwards for about one-third the diameter of the corallum, the secondary septa for about half the length of the former; stereoplasma not materially developed; dissepiments moderately developed, forming a zone of vesicular tissue around the

[1] *Loc. cit.*, t. 2, f. 3.
[2] *Ibid.*, t. 2, f. 4.
[3] Manual of Palæontology, 3rd Edit., 1889, I, p. 295.
[4] De Koninck also cites Colocolo.

periphery, usually curved outwards, becoming wider apart on their inward extension, and passing across the interseptal loculi direct; dissepimental vesicles small and irregular in shape in the outer zone, more or less quadrangular in the more open portions of the loculi; fossula large, extending nearly half across the corallum; cardinal septum short. Tabulæ well developed, close to one another, somewhat less than half the diameter of the corallum in width, horizontal or gently rolling. Epitheca moderately thick, concentrically lined; rugæ hid by the epitheca, corresponding to the interseptal loculi.

Obs.—The genus *Campophyllum* has not hitherto been recognised in Australian Carboniferous or Permo-Carboniferous rocks, although it is known to occur both in the Devonian of New South Wales and Queensland.

The present species is a well-marked member of the genus, and possesses a copious development of tabulæ (Pl. IX, Fig. 18), which lie very closely together—in fact, are almost in contact—and usually with a gently-undulating outline. In the absence of any definite curvature of the corallum, the fossula has been assumed to be dorsal, the cardinal septum being short, and extending but a brief distance into it.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, County Durham (*C. Cullen*):—Horizon doubtful, but perhaps Carboniferous.

Group—Cyathophylloidea.

Family—CYATHOPHYLLIDÆ.

Obs.—A coral referable to this family, and described by Professor De Koninck as *Cyathophyllum inversum*[1], found at Colocolo, has not come before me, but from its peculiar specific characters should be easily recognisable—indeed, these are of such a nature as almost to warrant its exclusion from the genus *Cyathophyllum*; nor have I seen his *Cyathaxonia minuta*[2] from Burragood. Two other species were also described, *Lithostrotion basaltiforme*[3] and *L. irregulare*[4], on which it is necessary to make a few remarks.

[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 146, t. 5, f. 4.
[2] *Ibid*, p. 153, t. 5, f. 10.
[3] *Ibid*, p. 145, t. 5, f. 2.
[4] *Ibid*, p. 144, t. 5, f. 1.

The coral called *L. basaltiforme* does not appertain to the European species of that name; neither does it belong to the genus, nor is it Carboniferous. I have already explained[1] that Carboniferous rocks do not occur, so far as we know, on the Murrumbidgee River, the locality from which the specimen was said to have come. The coral so named by De Koninck I have collected from the blue-black Siluro-Devonian (so-called) limestone of Cave Flat, at the junction of the Murrumbidgee and Goodradigbee Rivers. It is a *Cyathophyllum*, and only on a casual examination could have been mistaken for *L. basaltiforme*.

The locality of De Koninck's *Lithostrotion irregulare*, as given in his work, is certainly a Carboniferous one; but I cannot avoid the impression that a mistake has arisen in so assigning the specimen. It is suspiciously like, in general appearance, a coral I have described[2] as *Tryplasma Lonsdalei*, from the Upper Silurian of Hatton's Corner, near Yass.

Genus—CYATHOPHYLLUM, *Goldfuss*, 1836.

(Petrefacta, I, p. 54.)

CYATHOPHYLLUM ? ZAPHRENTOIDES, *sp. nov.*

Pl. X, Figs. 4–6.

Sp. Char.—Corallum of medium size, conical, compressed towards the base; section circular. Septa forty to forty-two, with an equal number of secondary lamellæ; primary septa generally straight, here and there a little curved, proceeding direct to the centre of the calice, untwisted; secondary septa rather less than half the length of the primary; dissepiments highly developed, extending inwards for half the length of the primary septa, irregular in direction, convex outwards, oblique, or at right angles to the septa; vesicles small and irregular in shape; stereoplasma well developed forming an outer zone rather more than a third as wide as the corallum. Tabulate area very small, if present.

Obs.—The systematic position of this coral is somewhat ambiguous. The quantity of vesicular tissue would indicate *Cyathophyllum* as its genus, whilst the manner in which the septa approach the centre, and the slight evidence of tabulæ point to *Zaphrentis*.

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[1] See Foot-note, p. 6.
[2] Records Geol. Survey N. S. Wales, 1890, II, Pt. 1, p. 15, t. 1, f. 1–6.

A section taken immediately above the base of the calice shows a small central space (Pl. X, Fig. 6), to which the septa have not converged, whilst in another taken somewhat lower in the corallum they appear to be gathered together on a small tabulate area, and there is also an indefinite subdivision into groups (Pl X, Fig. 5). The development of stereoplasma about the outer ends of the septa and the peripheral dissepiments gives rise to the appearance of a well-marked zone (Pl. X, Figs. 5 and 6).

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*):—Horizon doubtful, but probably Carbonifeous.

Cyathophyllum retiforme, *sp. nov.*

Pl. X, Figs. 13–15.

Sp. Char.—Corallum simple, cylindro-conical, straight, tapering very slowly; section oval or circular. Septa fifty-eight, with an equal number of secondary lamellæ, the former proceeding direct to the centre, although here and there a little curved; secondary lamellæ about half the length of the primary septa, very regular in size, length, and appearance, both more or less thickened with stereoplasma; dissepiments irregular in size and direction, forming with large and corresponding vesicles an outer zone; in an intermediate area between the thickened portions of the septa, the dissepiments are very short and small, the vesicles small and generally quadrangular, producing a more or less retiform appearance, whilst beyond the ends of the secondary lamellæ the dissepiments are less in number, distant, and direct, with oblong and narrow vesicles; stereoplasma thickening the septa but not infilling the loculi. Tabulate area small, and probably undulating or even vesicular.

Obs.—Although but an imperfect specimen the minute structure of this coral is so different from any other Australian Cyathophyloid that I feel called upon to name it as a memorandum for further investigation. There is an exterior zone of vesicular tissue in which the vesicles are moderately large and very irregular, practically forming the theca; internal to this is an intermediate area in which the secondary septa play their part. Here the vesicles are small, more or less quadrangular, bounded by direct dissepiments, producing a marked net-like appearance which is constant at various levels throughout the corallum. When seen in polished section on the specimen

the regularity and frequency with which these dissepiments branch from the septa produces a spurious but somewhat crenulated appearance, reminding one at first sight of the genus *Heliophyllum* (Pl. X, Fig. 15). Cut edges of tabulæ are visible in the central area, and would seem to show that the latter were either undulating or vesicular. The great regularity of the secondary septa and dissepiments between them reminds us of *Cyathophyllum inversum*, De Koninck, but the septa in the present instance are far more numerous, and other peculiarities of the dissepiments described by De Koninck are absent.

The fossula is not distinctly visible.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*) :—Horizon doubtful, but probably Carboniferous.

Family—CLISIOPHYLLIDÆ.

Obs.—Under the name of *Axophyllum Thomsoni*[1], Prof. De Koninck described a coral from Jervis Bay and Colocolo appertaining to this family, but I regret I have not seen it.

Genus—AULOPHYLLUM, *Edwards and Haime*, 1850,[2]

(Mon. Brit. Foss. Corals, Introd., 1850, p. lxx.)

Aulophyllum Davidis, *sp. nov.*

Pl. X, Figs 10–12; Pl. XI, Figs. 1–3.

Sp. Char.—Corallum very large, cylindrical, and much curved, with ill-defined irregular growth annulations. Septa fifty-eight to sixty, and an equal number of secondary lamellæ, straight, somewhat thickened, and the former equal to rather more than one-third the diameter of the corallum in length, the latter barely half the length of the primary. Peripheral area of the corallum, or interseptal space, narrow, the dissepimental vesicles rather small, closely packed, and apparently somewhat weak; intermediate area, or interlocular space, composed of irregular large concave vesicles, the secondary septa passing on to, but hardly beyond this area; interlamellar space, or

[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 143, t. 3, f. 3.
[2] Emended, Duncan and Thomson, Quart. Journ. Geol. Soc., 1867, XXIII, p. 327.

central area, composed of tabulæ, usually vesicular, but sometimes complete —when incomplete the vesicles are large, low, and directed upwards—the marginal vesicles much bent downwards at their junction with those of the interlocular area, and thus assisting to form the so-called inner mural investment; when viewed horizontally this space has the appearance of a tabulate area, and the primary septa impinge somewhat on it. Fossula slightly longer than the primary septa, the cardinal septum very short, and the counter septum not specially developed. Epitheca thin; rugæ corresponding to the interseptal loculi.

Obs.—The definite tripartite division of the corallum assigns this coral at once to the Clisiophyllidæ, whilst the development of a tabulate central area, representing the pseudo-columellarian mass of other members of the family, with the inner mural investment, indicates, to my mind, the genus *Aulophyllum*, Edwards and Haime, as emended by Duncan and Thomson.

The broken concentric lines visible on the central tabulate area, at first sight, partake, to some extent at least, of the characters of the spirally-twisted plates forming the central mass of *Clisiophyllum*, *Rhodophyllum*, *Dibunophyllum*, and other members of the family; but a glance at a vertical section (Pl. XI, Fig. 3) will at once dispel this idea, and show that these lines are simply the cut or broken edges of vesicular tabulæ, the specimens having been more or less compressed laterally.

From *Aulophyllum Edwardsi*, D. & T., the type of the genus, our species is distinguished by its much greater size, less number of septa, and relatively wider areas.

A. Davidis is named in honour of Mr. T. W. Edgeworth David, B.A., of the Geological Survey.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*):—Horizon doubtful, but probably Carboniferous. Torryburn, Logan's Station, twelve miles from Paterson, Co. Durham (*Rev. W. H. Yarrington, M.A.*):—Horizon ditto.

Section B.—PERFORATA.

Family—FAVOSITIDÆ.

Obs.—Only two genera of Favositidæ have come under my notice—*Trachypora*, Edwards & Haime, and *Michelinia*, De Koninck. The former is by far the richest numerically, although one species of each is only known, but the latter is very rare.

The described species of *Trachypora* are Devonian, but Prof. H. A. Nicholson[1] has suggested that by the union of other hardly-separable genera "the genus will ultimately be shown to range from the Upper Silurian to the Carboniferous." *Michelinia* occurs both in the Devonian and Carboniferous.

Genus—TRACHYPORA, *Edwards and Haime*, 1851.

Trachypora, Edw. & H., Archiv. Mus. Hist. Nat. Paris, 1851, V, p. 305.
„ Nicholson, Tab. Corals Pal. Period, 1879, p. 102.

Gen. Char.—Corallum dendroid, of complex cylindrical stems, attached basally to foreign bodies, and composed of conical corallites which diverge with an increasing curvature from an imaginary axial line to open on all parts of the free surfaces. Corallites essentially polygonal, in close contact, their proper walls usually not obliterated, and in no case separated by the intervention of a true cœnenchyma. Interior of the tubes contracted by the deposition of numerous concentric layers of sclerenchyma, which increase in amount as the surface is approached. Calices superficially widely distant from one another, arranged in irregular longitudinal rows, the interspaces between them, formed by their enormously-thickened lips, being ornamented with grooves or ridges. Septa represented by radiately-placed spines or tubercles, or obsolete. Tabulæ few, remote, complete. Mural pores generally well marked, but few and irregular (*Nicholson*).

Obs.—Without entering into the relations of *Trachypora* to *Dendropora*, Michelin, and *Rhabdopora*, Ed. & H., which have been so ably handled by Prof. Nicholson, it affords me much pleasure to introduce a form from the Upper Marine Series, which appears to be a species of the first-named genus, in some of its characters bridging over the interval between it and

[1] Tab. Corals Pal. Period, 1879, p. 106.

Striatopora, Hall. These genera differ by the fact "that the thickening of the immediate periphery of the calices is carried to a much more extreme extent" in *Trachypora* than in *Striatopora*, caused by the deposition of an excessive quantity of selerenchyma in the interior of the corallites. This results in the formation of a much larger extent of free surface exteriorly between the calices, which is ornamented with grooves and ridges. Such is the structure of the species about to be described, but it undoubtedly also approaches *Striatopora* in the somewhat erect, sub-angular, and polygonal mouths of the calices, and the highly-developed septal striæ.

A microscopic examination of this species—which it is proposed to call *T. Wilkinsoni*, in honour of the Government Geologist—enables me to quite support Prof. Nicholson's statement[1] that there is no proper cœnenchyma nor a columella in *Trachypora*. Lastly, it has been proposed to unite the Carboniferous genus *Rhabdopora* with the present, a union which will receive some support from the geological position of *T. Wilkinsoni*.

Trachypora Wilkinsoni, *sp. nov.*

Pl. I; Pl. VI, Figs. 1 and 2.

Sp. Char.—Corallum of stout cylindrical bifurcating stems, from four to six lines in diameter, but increasing to nine lines immediately previous to bifurcation, sometimes giving off additional blunt abortive branches, with the entire free surface, like that of the parent stems, occupied by calices, and presenting a roughened hackly appearance from their exsert mouths. The latter are round or oval, of variable size, the larger about three-fourths of a line in diameter, irregularly placed as to size, arranged roughly in longitudinal rows, and their mouths set a little obliquely to the longer axes of the corallites, but the lower edge of each calice slightly exsert. Intercalicular surface extensive, ornamented with irregular vermicular ridges and tubercles, the former sometimes assuming a roughly radiate appearance. Septa represented by very conspicuous radiating ridges within the calice mouths, separated by intervening deep grooves. Tabulæ irregularly placed, sometimes remote, at other times contiguous, both horizontal and oblique. Mural pores small and irregularly distributed.

[1] Tab. Corals Pal. Period, 1879, p. 104.

Obs.—When the surface of the corallum becomes at all worn the slight obliquity of the calice mouths is entirely lost, and the septa are then visible round the otherwise rather funnel-shaped calices. They vary from eight to ten, and the intermediate depressed spaces, or grooves, are even more conspicuous than the septa themselves.

Both in longitudinal and transverse sections, the enormous thickening of the walls towards the peripheral portion is very apparent, and in some cases the calices become almost obliterated by it, although the primordial walls are usually still to be seen, and the original polygonal outline of the corallites. This thickening increases towards the periphery of the corallum. The great length of the corallites is also noticeable in vertical sections, and the fact that they remain open throughout their whole course, the outward curvature from the central or axial portion of the corallum being a gentle one. The corallites are in close contact with one another, but even at an early point in their course the same thickening of the walls is visible, although to a less extent than towards the peripheral portion. The complete tabulæ are placed at variable distances apart, sometimes horizontal, at other times oblique to the axial line of the corallites they traverse.

When well preserved the margins of the calices are erect and thickened; this, with their deep funnel-shaped interiors and strong septa at once recalls the structure of *Striatopora*, Hall.

The pores are very irregularly distributed. In some cases they occur singly, at other times are clustered together. They are quite round, and, for the size of the corallite, large. Some very instructive internal casts of the calices of this coral have been found at Boorook, (Pl. I, Fig. 8) in which not only the grooves left by the imprint of the septal striæ are visible, but projecting from these casts, either at right angles or at a slightly-inclined angle, are a number of thorn-like projections, which are the infillings of the pores placing the various corallites in communication with one another. The whole of the immensely-thickened walls have been removed, but the ornamentation of the surface is preserved on the impression of the fossil. The distance apart of these "thorns" excellently demonstrated the thickness attained by the secondary deposit. It is quite clear that not only the peripheral portions were thickened, but the central vertical portions of the tubes likewise, whilst the proper wall is very apparent. There can be no possibility of doubt that the septal ridges extended for some distance into the calicular orifices, as shown by the grooves on their internal casts.

A peculiar instance of contrariety of growth is shown in Pl. I, Fig. 3, where the calices at either end of the specimen have grown in opposite directions opening towards one another.

Trachypora Wilkinsoni is, with *Stenopora crinita*, one of our most characteristic[1] corals of the Upper Marine Group.

Locality and Horizon.—Mulbring (Mount Vincent), near West Maitland, Co. Northumberland (*Messrs. T. W. E. David, B.A., C. Cullen, —Twine, and S. Dodds*); Barren Flat, Shoalhaven District, Co. St. Vincent (*H. Moss*); Shoalhaven, Co. St. Vincent (*C. Cullen*):—Upper Marine Series. Boorook,[2] Co. Buller (*D. A. Porter*):—? Upper Marine Series.

Genus—MICHELINIA, *De Koninck*, 1842.

(Descrip. Anim. Foss. Terr. Carb. Belgique, Fas. 1, p. 29.)

Michelinia, *sp.*

Plate IV, Fig. 1.

(Comp. *Michelinia tenuisepta* (Phill.), Edwards and Haime, Mon. Brit. Foss. Corals, 1852, Pt. 3, p. 155, t. 44, f. 1, 1 *a-b*.

Obs.—A portion of a small specimen represents the only example of this genus which has come under my notice from Australian Permo-Carboniferous rocks. The specimen has been broken across, and, although somewhat obliquely, the character of the corallites is well displayed. The epitheca is not well preserved, nor are there remaining any radiciform processes, even if the species possessed them, which I think doubtful. The calices are from seven to nine millimetres wide, but as the surface has been fractured obliquely, the actual diameter would be less. The tabulæ, from their peculiar arrangement, give rise to the characteristic vesicular tissue, the vesicles being small and very numerous, but there are no septa visible. The walls of the corallites are moderately thick, and freely pierced by numerous irregularly-placed pores, giving to them under the hand-lens a slightly cribriform appearance. Vertical spinules on the tabulæ are not visible.

[1] The original specimens used by me were limited in number, and poor in outward preservation, compared with a very fine and large collection since made at Mulbring by Mr. Cullen. Many of these exceed the measurements given above, but the largest fragment which has come under notice is a specimen three inches long, with a diameter of one and a quarter inches, presented by Mr. Twine.

[2] The ultimate geology of this district appears to be but little known. In the late Mr. Lamont Young's "Report on the Boorook Silver Mines" (Ann. Report Dept. Mines N. S. Wales for 1878 [1879], p. 35) the silver lodes are said to be associated with shales of Upper Devonian age. The fossils, however, which have come under my notice so far from this locality do not differ from those of the Permo-Carboniferous areas.

The presence of so little of the corallum renders specific identification difficult—indeed, almost impossible—but it may be pointed out that the absence of radiciform processes, and the general appearance of the vesicles, would indicate *Michelinia tenuisepta*, Phillips[1], as its nearest ally.

Locality and Horizon.—Carrol, near Somerton, Co. Buckland (*D. A. Porter*[2]) :—Horizon doubtful, but probably Upper Marine Series.

Family—SYRINGOPORIDÆ.

Obs.—The second family of the Perforata, of which we have any record, is the Syringoporidæ, but unfortunately the Collection does not at present contain examples. The late Prof. De Koninck described two species—*Syringopora reticulata*, Goldfuss[3], from the Upper Marine Group of Muree, near Raymond Terrace, Hunter District; and *S. ramulosa*, Goldfuss[4], from the Lower Carboniferous rocks of Burragood, Paterson River. Both specimens formed a portion of the Rev. W. B. Clarke's Collection, and were destroyed in the Garden Palace fire. The figure of the first-named has very much the appearance of an irregularly-grown, openly fenestrate *Fenestella* seen from the reverse side. That of the second species closely resembles the impression of some of our *Protoreteporæ*.

Family AULOPORIDÆ.

Genus—CLADOCHONUS, *M'Coy*, 1847.

Jania (pars), M'Coy, Synop. Carb. Lime. Foss. Ireland, 1844, p. 197. (Non Lamx).
Cladochonus, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 227.
Pyrgia, Edwards and Haime, Archiv. Mus. Hist. Nat. Paris, 1851, V, p. 310.
Cladochonus, De Koninck, Nouv. Rech. Anim. Foss. Terr. Carb., Belg., 1872, Pt. 1, p. 150.
„ Nicholson and Etheridge, jun., Geol. Mag., 1879, VI, p. 289.
„ Nicholson, Tab. Corals Pal. Period, 1879, p. 222.

Gen. Char.—Corallum in the form of an erect branching colony, fixed at the base, by one or more isolated points of attachment; composed of thick conical corallites, suddenly dilating at regular distances into cup-shaped terminal calices, either singly or in groups, when singly usually bent from

[1] *Calamopora*, Geol. Yorkshire, 1836, Pt. 2, p. 201, t. 2, f. 30.
[2] A second specimen has lately been presented by Mr. Porter, somewhat larger and better preserved than the above. In this the tabulæ are highly vesicular and convex.
[3] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 155, t. 7, f. 3.
[4] *Loc. cit.*, p. 156, t. 7, f. 4.

one another alternately in opposite directions, successive corallites taking their rise from the base of the preceding calice. Tabulæ sometimes present, at others absent, the visceral chambers connecting freely by their bases; when present, remote, delicate, and complete. Septa representedby delicate striæ. Epitheca strong. Increase takes place by lateral budding.

Obs.—"These singular and beautiful corals," says Prof. M'Coy,[1] "have some relation to *Aulopora*, but differ in their curious erect habit, regular, angular mode of branching, slender, equal, stem-like tubes and abruptly-dilated terminal cups bent in nearly opposite directions. The *Aulopores* are attached for the most part by one side; the tubes *gradually* expand to the mouths, which all open nearly in one direction; they have no regular distance for branching, and frequently anastomose. The present corals have also much thicker walls to the tubes, the central hollow being proportionally very small."

According to Prof. L. G. De Koninck,[2] the tubes of the European *Cladochonus Michelini* communicate freely with one another. I have only examined a limited series of *C. tenuicollis*, but they are certainly similar in structure. Other specimens, however, from the Carboniferous Limestone of Scotland, described by Prof. Nicholson and the Writer, and believed to be *C. Michelini*, were found to possess remote, delicate, and complete tabulæ, either straight or slightly curved. The relation of this genus to *Aulopora* has been summed up by Prof. Nicholson[3] in the following words—"There is nothing in the internal structure of *Cladochonus*, M'Coy (= *Pyrgia*, Edw. & H.), which would separate it from *Aulopora*, Goldf., and the generic distinctness of the two can only rest upon the feature that the corallum of the former is erect, whereas in the latter it is creeping and parasitic."

Cladochonus tenuicollis, *M'Coy*.

C. tenuicollis, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 227, t. 11, f. 8.
„ De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 154, t. 7, f. 2.
„ Etheridge, Junr., Cat. Australian Foss., 1878, p. 34.

Sp. Char.—Corallum branching in the form of an irregular zigzag, but more or less in the same plane. Calices large, obliquely-oval, cup-shaped, and terminal, united towards their bases by slender pipe or pedicle-like corallites, composed of a thick homogeneous tissue, the internal connecting passage

[1] Ann. Mag. Nat. Hist., 1847, XX, p. 227.
[2] Nouv. Rech. Anim. Foss. Terr. Carb. Belg., 1872, Pt. 1, p. 153.
[3] Tab. Corals Pal. Period, 1879, p. 223.

remaining very narrow; the calices are usually single, alternately springing from the stolon-like corallites right and left, occasionally, however, two issue from the same corallite, more or less opposite one another. Tabulæ absent. Septa, as very fine and numerous striæ, extending the whole depth of the calices.

Obs.—Prof. De Koninck has very aptly expressed the form of this peculiar coral by comparing the separated corallites to an ordinary clay-pipe. As a rule, the calices spring from the stolon-like corallites singly, but at times two appear to issue from the same pedicle.

The tissue composing the corallites is very dense, and apparently fibrous, the connecting passages very narrow, and no evidence of tabulæ has been observed. With the exception of a very small portion of surface of one of the calices, the tissue appears to be perfectly homogeneous, but at this point a vermicular structure is apparent. I regret that the material at my disposal is too limited in quantity to warrant the preparation of microscopic slides, and I am, in consequence, unable to institute a comparison with the structure of the genus *Monilopora*, N. & E[1]. Should further research establish the presence of a reticulate structure in the Australian coral it will necessitate a re-examination of *Monilopora*.

Locality[2] *and Horizon.*—Three-quarters of a mile north-west of Pallal Station, Horton River, Co. Murchison (*C. Cullen*) :—horizon doubtful, but probably Carboniferous. Dungog Road, nineteen miles from West Maitland, Co. Durham, (*Messrs. J. Waterhouse, M.A.; T. W. E. David, B.A.*, and *R. Etheridge, Junr.*; and *C. Cullen.*) :—Mirari Limestone, Carboniferous.

Order ?—MONTICULIPORIDEA.[3]

Family—MONTICULIPORIDÆ.

Sub-Family—Stenoporinæ.[4]

Obs.—The family Monticuliporidæ has been subdivided by Messrs. Waagen and Wentzel into three sub-families, of which the Stenoporinæ forms the third, and is certainly a most convenient section. They place in it two genera—*Stenopora*, Lonsdale, and *Geinitzella*, W. & W. To these I would add *Tabulipora*, Young, for reasons to be explained later.

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[1] Geol. Mag., 1879, VI, p. 293.

[2] The following localities had been previously given—Dunvegan by Prof. M'Coy (Ann. Mag. Nat. Hist., 1847, XX, p. 227), and Burragood by Prof. De Koninck (Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 154).

[3] "Zoological affinities uncertain," Nicholson, Manual of Palæontology, 3rd Edit., 1889, I, p. 89.

[4] Waagen & Wentzel, Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 875.

The following brief scheme explains their respective positions :—

- Walls with periodical moniliform swellings more or less developed
  - Moniliform swellings rudimentary
    - Tabulæ complete
      - *Geinitzella.*
      - *Stenopora.*
  - Moniliform swellings well developed
    - Tabulæ incomplete
      - *Tabulipora.*

Genus—STENOPORA, *Lonsdale*, 1844.

Stenopora, Lonsdale, in Darwin's Geol. Obs. Volc. Islands, 1844, p. 161 (*note*)

„ Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 262.

Tubuliclidia, Lonsdale, Bull. Soc. Géol. France, 1844, I, p. 497.

„ Lonsdale, in Murchison's Geol. Russia, &c. 1845, I, pp., 221 & 631 (*note*).

Stenopora, Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1879, IV, p. 265.

„ Nicholson, Tab. Corals Pal. Period, 1879, p. 168.

„ Waagen & Wentzel, Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 885.

(Compare *Geinitzella*, Waagen & Wentzel, *loc. cit.*, p. 880.)

Gen. Char.—Corallum ramose (arborescent) or sublobate, sometimes massive, occasionally frondescent, attached to foreign bodies, usually by the centre of its base, and composed of tubular corallites, which are nearly vertical in the centre of the corallum, and radiate outwards from an imaginary axis at various angles to open on all points of the free surface. Corallites polygonal, thin-walled, and more or less completely in contact; in the outer, curved, or peripheral portion of their course more or less cylindrical, and annulated by periodical ring-shaped thickenings, which are sometimes placed at corresponding levels in contiguous tubes. Visceral chambers in the outer portions of the tubes alternately contracted and dilated in correspondence with the periodic thickening of the walls just spoken of, but open and subpolygonal in the axial portion of the corallum. Acanthopores usually present.

Septa obsolete. Tabulæ remote, usually placed at corresponding levels in contiguous tubes, but at irregular distances within the same tube, generally complete, but sometimes perforate, especially at the final period of growth of the corallites, when the calices at times appear with their terminations closed by a perforated lid. Mural pores absent. The massive forms usually have the corallites constricted at intervals on the same level, representing periodic stages of growth, and giving to the entire mass a stratified appearance. Gemmation intermural.

Obs.—The corallum in *Stenopora* is usually more or less branched, but the branches may be so thick, or may so extensively coalesce, that its general form becomes that of a lobate mass. The corallites radiate in all directions from an imaginary axis, and present very different appearances in the central and circumferential portions of the corallum respectively. In the central or axial portion the tubes are nearly vertical, essentially polygonal or prismatic in shape, have thin walls, and are nearly or quite in contact with one another throughout. As they pass upwards the tubes gradually diverge, coming at last to be nearly horizontal, and preserving this direction for a considerable distance, till they at last open upon the surface. There is thus an exterior zone of the corallum, in which the corallites are nearly transverse to the axis of the branches, and in this region they have a generally cylindrical appearance. We are too little acquainted with the perfect corallum in the majority of species to speak definitely as to its ultimate outline in each one. *Stenopora ovata*, *S. Leichhardti*, *S. australis*, and *S. tasmaniensis* are all ramose species so far as we know them, but I have reason to suspect that the first three, in this condition, are but the terminal and younger portions of much more massive coralla, perhaps arising from coalesced branches, but hardly, I think, from definitely-grown lobate masses like *S. crinita*. It will be shown further on that even this species does at times shoot forth from its otherwise undulating and semi-mammillated surface out-growths of a ramose character. I have been favoured by Mr. R. M. Johnston, F.L.S., of Hobart, with a Tasmanian foliated *Stenopora*, the corallum growing in rather undulating tabular or foliated expansions, like that of *Chætetes hyperboreus*, N. & E.,[1] the corallites opening on the free lateral surfaces, and arising from a median line, and imaginary axis.[2]

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[1] Nicholson & Etheridge, Junr., Proc. Linn. Soc. (Zool.), 1878, XIII, p. 367.

[2] Two such forms of growth have already been mentioned by Prof. H. A. Nicholson and the Writer, both from Tasmania, and now in the British Museum. The microscopic structure of one was compared to that of *S. ovata*; the other, "a remarkable frondescent specimen," was compared to *S. tasmaniensis*.

Specimens fractured longitudinally usually exhibit the corallum subdivided in a similar direction into a number of superimposed strata of greater or less thickness. No better example of this can be adduced than in Lonsdale's old figure of *Stenopora ovata*, and it is equally well shown in our Pl. II, Figs. 1 and 2, Pl. III, Figs. 2 and 3, and Pl. IV, Fig. 2. These strata, or corallite internodes, it is believed, indicate periods of growth, a cessation of active increase taking place at the upper line of each stratum, and not merely lines of high tabular development, as in some corals. They are usually well marked in most of the species, but probably more apparent in *S. crinita* (Pl. II, Figs. 1 and 2), and *S. ovata*; and least so in *S. tasmaniensis*.

Fractured surfaces of *S. Leichhardti* present even a plumose appearance, arising from a slight tendency of the branches to expand at their apices. The same feature is to some extent noticeable in another species from the chloritic rock of the Gympie Gold-field.

The general features of the surface in the Australian *Stenoporæ* are moderately uniform, but in *S. crinita*, as will be explained later, monticules have been noticed (Pl. V, Fig. 1). At the same time, other important modifications may become apparent when we become better acquainted with the exterior of the corallums of some of the other species.

We know equally little regarding the method of attachment of the corallum in *Stenopora*. In our earlier description of the genus, Prof. Nicholson and the Writer used the term "rooted below," and although it is still quite possible that some of the species may have been so fixed to submarine bodies, we now have definite evidence that at least one species, *S. crinita*, was firmly attached (Pl. III, Figs. 1 and 2) by its general base to other objects, and in fact enveloped them. The undescribed Tasmanian species cannot be said to be encrusting, as the foliations are bilaminar, and it is therefore within the range of possibility that this may have been a rooted form. Taking a typical *Stenopora*, thin sections of the corallum show different appearances in different portions. Thus, in a transverse section across a branch, the axial corallites are seen to differ in no essential features of their structure from those of *Monticulipora* or *Favosites*, except, of course, that there is no trace of the septal spines of the latter. Each possesses its own wall, which is not abnormally thickened, the boundary between contiguous tubes being clearly indicated, generally by a distinct dark line. The tubes in

this portion of the corallum are also regularly polygonal (triangular, hexagonal, heptagonal, and pentagonal), and variable in size, and are certainly, as a rule, in close contact. On the other hand, in sections tangential to the branch, and taken a little below the surface, the tubes are cut across on their outer portions, where they are periodically thickened. The tubes still appear to be polygonal and in contact, each being bounded externally by a well-marked dark line; but the appearances presented by the area within this boundary-line apparently vary according as the section traverses the tubes at the level of their thickened portions, or at that of the unthickened intervals between the latter. In the former case the visceral chamber is seen to be greatly contracted, and may even be reduced to a comparatively small rounded or sub-polygonal central tube, which is, in turn, surrounded by a thickened ring of sclerenchyma, which usually shows distinct traces of its being composed of successively-deposited concentric laminæ. In the latter case there is still a ring of sclerenchyma within the dark outer polygonal boundary; but this ring is of small thickness comparatively, and the central tube is wide and open. The walls are thickened at short intervals by annular accretions of growth, the portions of the tubes between them retaining their normal diameter. These thickened portions are usually placed at corresponding levels in all the corallites.

In many parts of tangential sections the corallites exhibit few features that would satisfactorily separate them from similar sections of certain Monticuliporidæ, though they usually have exceptionally thick walls, and often exhibit a dark ring a little within the true wall, and concentric with the latter.

Longitudinal sections of the corallites show the periodical annular thickenings of the tubes in a very instructive manner, and demonstrate that these are really thickenings of the wall, projecting both externally and internally—in fact, the longitudinal section of the wall has a regularly moniliform appearance, owing to its successively traversing thickened and unthickened segments. Sections of this kind also show that there exist remote and usually complete tabulæ, which are generally placed at approximately corresponding levels in all the corallites of a single colony.

Such being a general view of the corallum of *Stenopora*, we may now consider some points of its structure in detail. The secondary deposit which forms so conspicuous a feature in the tubes of most New South Wales and

Queensland *Stenoporæ* presents some interesting points of study. It is composed of concentric zones of successively-deposited matter, and, when present, regularly follows the outline of the corallite, which it assists in filling up. This is seen to greatest advantage in *S. crinita*, and from the varying colours of the laminæ is best compared to the concentric structure of a nodule of clay ironstone, which it much resembles.

In *S. crinita*, *S. ovata*, and *S. tasmaniensis* it completely follows the outline of the tubes, but it is always much less marked in the last-named species. In the two first-named the corallite wall is generally succeeded by a zone of clear calcite, this by a ring of dark ferruginous deposit of greater or less thickness, at times a mere ring, at others broadening into a zone; this again by another layer of clear calcite, which may or may not completely fill the visceral chamber. In the latter case its inner or free margin is ragged, the centre being occupied by matrix, or a subsequent infiltration of carbonate of lime (Pl. VI, Figs. 3 and 4). There are even degrees and variations in this structure, for it sometimes happens that beyond the first dark ring the whole chamber is filled with clear calcite, or this ring may expand into a broad zone completely infilling the tube. In some few examples of *S. ovata* the outline of the tubes is followed immediately by a pale-coloured ring of sclerenchyma, of radiately fibrous structure. In vertical sections of *S. crinita* the moniliform walls are invested in a somewhat similar manner.

In *S. australis* a modification of this secondary investment is seen. It is never in contact with the polygonal wall for more than half or two-thirds of its circumference, being separated from the remaining part of the tube by a distinct and conspicuous interspace, which is filled in the fossil with transparent calcite. Not only is this partial interspace between the inner ring and the outer wall apparently always present, but it seems to be always situated upon the same side of all the corallites in any particular section.[1]

It has already been mentioned that *S. tasmaniensis* exhibits this filling of the tubes to a far less extent than the other species mentioned; and it is a peculiar fact that in all the Tasmanian species examined by me[2] the deposit is absent, but in the Indian forms of *S. ovata* it is to some extent developed.[3] In the case of *Stenopora australis* the peculiar appearance there

[1] Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1879, IV, p. 272; *Ibid*, 1886, XVII, t. 3, f. 5.

[2] With the exception of *Stenopora informis*.

[3] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 1c.

present was accounted for by Prof. H. A. Nicholson and the Writer[1] on the supposition that the tabulæ, in the first place, were perforate, and in the second, incomplete. The facts, however, detailed above, and those to be given later under the heading "tabulæ," do not appear to bear out this opinion, which, I think, must be abandoned. I can, after a further and more extensive acquaintance with *Stenopora*, only arrive at the conclusion that this peculiar investment, in spite of its extraordinary development, is principally of inorganic origin, and is produced by a post-mortem deposition within the cavities of the tubes, as indicated by its presence in some examples and not in others.[2]

The proper wall in its unthickened state is exceedingly uniform in appearance and thickness, and is usually visible as a dark line, so thin and structureless as to render any subdivision between contiguous corallites perfectly imperceptible, and thus resembling such Monticuliporoids as *Monticulipora (Diplotrypa) petropolitana*, Pander, sp.[3] This appearance is particularly characteristic of Tasmanian specimens, but in no Australian example have I met with that peculiar disintegration into dots, resembling a string of beads, figured by Waagen and Wentzel in the walls of the Indian variety of *S. ovata*.[4] Nor has the slightest indication presented itself of such wall-structure as characterises *Monticulipora (Heterotrypa) ramosa*, D'Orb.,[5] wherein each visceral chamber is enclosed by a dark line or marginal ring, usually circular or oval in outline, marking the original boundary of the tube, and the interspaces between these dark lines filled in by sclerenchyma of a different texture and much lighter colour.

It has been supposed by Prof. H. A. Nicholson that in the Monticuliporidæ each tube or corallite theoretically possesses a perfectly independent and complete wall,[6] that is, of two thin laminæ adpressed, each appertaining to a separate corallite. Theoretically, no doubt, this view of the Monticuliporoid wall-structure is strictly accurate, but in *Stenopora* I have quite failed to detect, by direct microscopic examination, except in *S. crinita*, any bilaminar structure in its walls, as also did Messrs. Waagen & Wentzel.[7]

[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 176.

[2] As a further proof of this, I may mention that a specimen of *S. crinita* has recently come before me from the Wollongong District, in which the corallites are almost completely destitute of secondary deposit. This is of great importance, from the fact that Wollongong is amongst the localities which have yielded the best specimens showing the secondary deposit.

[3] Nicholson, Genus Monticulipora, &c., 1881, p. 37, f. 1A.

[4] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 1c.

[5] Nicholson, *loc. cit.*, p. 39, p. 37, f. 1B.

[6] Nicholson, *loc. cit.*, p. 36.

[7] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 863.

If, therefore, we dismiss such an arrangement of these important structures, how is it that on longitudinal fracture the exterior of the various corallites has usually been supposed to be on view. According to the authors just referred to, such is not the case, and they have advanced the following ingenious explanation to account for it. Speaking of the peripheral region of a Monticuliporoid coral, they say that longitudinal severance always takes place along the primordial wall, the latter adhering to one side of the fracture, the secondary thickening retaining its connection with the other side of the break. In the axial zone fracture takes place in the same manner, but there being little or no secondary thickening the other side of the break exposes "the smooth internal cast of the adjoining individual."[1] Appearances presented by our *Stenoporæ* seem to me explicable only on this supposition. The wall in freshly-fractured specimens appears as a thin pellicle-like substance of light colour, and peels off as such. In *S. crinita* this peculiarity is so marked that when combined with the stratified condition of the corallum the corallites of a given growth-stage break off as individual disjointed hexagons, octagons, or polygons, as the case may be. The presence of intermural gemmation in *Stenopora*, almost exclusively, would lead us, to some extent, to expect the exposure of the exterior of the corallites on fracture, and not, as in *Chætetes*, in which fissiparity exists, the interior. From these combined causes, therefore, it is very difficult to account for the appearance of the interior as in *Stenopora*, unless it be by the above hypothesis. A condition of preservation which would appear to go far to bear out this view occurs in *S. crinita*, in which the longitudinal surfaces of what Waagen and Wentzel would call the internal casts of the tubes are invariably marked by the impressions of downwardly-directed crescentic imbrications of microscopic size. These, I believe, are the impressions of the superimposed conical layers of sclerenchyma composing the moniliform annulations of the walls, left after fracture, as explained by the authors above quoted.

The structure of thickened portions of the walls is identical, whether the section be taken from the axial region, as in *S. crinita*, or the peripheral zone of another form, and the polygonal outline becomes lost. The transition from the dark, hair-like proper wall (Pl. VII, Figs. 2 and 3) to the mass of sclerenchyma forming the thickened wall is always abrupt, but the moment this has taken place the structure becomes well exemplified, the sclerenchyma or concentric fibro-laminar deposit, probably representing the obliquely-cut edges of the superimposed layers of which the thickened annulations are

[1] *Ibid.*, p. 864.

composed. The laminæ, when visible, are invariably concentric to each corallite wall, but often do not extend to the centre of the interstice, in which case a more or less undefined narrow central space is left, common to the two adjoining tubes (Pl. VII, Fig. 4). This is either apparently structureless and homogeneous, and free of the concentric lines, or is occupied by the primordial wall, which, in these cases, remains in the thickened wall of sclerenchyma as a simple dark line (Pl. VII, Fig. 3). The median space, when structureless, may be, generally speaking, narrow and contracted, or, as in certain Tasmanian species, the frondescent condition of *S. ovata* for example, very wide. As regards the superficial area of these structures there does not appear to be any fixed rule. One or the other may occupy the whole microscopic field, or there may be only very limited portions of it so taken up.

In longitudinal sections, whether of the axial or peripheral region, the structure, as apart from the arrangement of the periodical moniliform thickenings, is identical, and strictly follows the general plan of other Monticuliporoids, as described by Prof. H. A. Nicholson[1] in peripheral sections, being a "succession of superimposed conical layers of sclerenchyma, which are deposited one above the other as the growing margin of the wall is carried upwards." Different appearances are produced according to the position in which a corallite is sectioned. If the section runs truly across the centre of the corallite we simply have presented to us the thickened lateral peripheries of the tube[2] (Pl. VI, Figs. 7 and 8; Pl. VII, Figs. 1 and 9); but if the section is taken contiguous to either the fore or aft wall we then see, in addition, a deposit of sclerenchyma also of a fibro-laminar structure[3] (Pl. VII, Fig. 5), thrown into a series of folds, concave downwards, and thus differing from the "superimposed layers" described by Prof. Nicholson. These diverse appearances are common in all good sections, and may be studied in the figures referred to below. In one singular section (Pl. VII, Fig. 6) the fusiform thickenings are hollow, with only the bounding walls preserved.

The chief modifications observed in the periodical thickenings of Australian species are the following:—In the axial region of *S. crinita* (Pl. VI, Fig. 6), this being the only form in which axial swellings are developed with anything like frequency, the latter are elliptical or fusiform in outline,

[1] Genus Monticulipora, &c., 1881, p. 41.

[2] Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 4 & 8; Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 1*d*.

[3] Ann. Mag. Nat. Hist. 1886, XVII, t. 3, f. 10; Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 3 *d* & *e*.

small, often single, and at the same level over a considerable extent of the corallum, and having the appearance, under a low power, of strings of widely-separated semi-transparent beads. At times the wall, above or below, usually above, is to some extent thickened, and it may happen that at times several swellings follow one another rapidly, but without becoming confluent. In *S. tasmaniensis* and *S. ovata*, when moniliform swellings do occur in their axial regions, they are much on the same plan as the above. On examining the peripheral region of the several species we find a much greater diversity of structure existing. In *S. ovata* the annulations of the tubes, on the latter passing from the axial to the peripheral zone, gradually lose their elliptical form and become oval-pyriform, approaching nearer to one another as the surface of the corallum is approached. Although becoming ultimately close set and forming a continuous line, with great regularity, like a series of waves, the swellings never thoroughly lose their pyriform outline, and, in consequence, do not become confluent. The moniliform swellings of *S. australis*, N. & E.,[1] are similar, but those of the axial region of this species and *S. Leichhardti* I am not acquainted with. Near the surface of the corallum many of the swellings in *S. ovata* are quite cæpiform (Pl. VI, Fig. 8), and appear to have their larger ends reversed. In *S. Leichhardti*, N. & E.,[2] the swellings have quite lost the moniliform or annular outline, and have become perfectly confluent, except just at the periphery of the corallum, where the characteristic form may still be recognised. The aspect usually presented in sections of this species is that of a series of thickened walls, gradually increasing in width upwards, with uniform margins, or at any rate only widely serpentine. In *S. tasmaniensis* the moniliform swellings are, when single, generally elliptical, but sometimes cæpiform, but, as a rule, the whole peripheral line in this species becomes thickened into a dense mass of sclerenchyma (Pl. VII, Fig. 9), but in which the laminar structure is still visible. Lastly, in *S. crinita* the moniliform swellings appear, at the termination of growth periods, to retain the same general character as in the axial region, simply becoming closer together, but still possessing the same fusiform appearance. One very characteristic feature, however, in these bodies is their much more slender outline than in any of the others.

The interstitial surface of the corallum and the angles between the corallites are more frequently than not occupied by small blunt spines which project more or less above the general surface. These have been termed by

[1] Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 6.
[2] Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 8.

Prof. Nicholson[1] "spiniform corallites," and by Messrs. Nicholson and Foord[2] "acanthopores. They are, apparently, the "wandröhrchen" of Dybowski[3], and the "newly-developed gems" of Messrs. Waagen and Wentzel[4]. I have only had an opportunity of macroscopically examining two Australian species, *S. tasmaniensis* and *S. ovata*. The characters of the surface in the first will be found under its specific description, but in *S. ovata* the acanthopores do not appear to have that marked spiniform appearance so noticeable in the former species. This, however, may perhaps be due to imperfect preservation.

In sections of the characteristic New South Wales species, *S. crinita*, acanthopores are of variable occurrence. They appear in some specimens at all the angles between the corallites, but in other cases whole sections may be examined without a single acanthopore being present, notwithstanding that the walls of the corallites are thickened. In *S. ovata* the acanthopores are of large size, almost always at the angles, and very frequently on the interstitial surface. In *S. australis*, acanthopores have not, so far, been observed; but in *S. Leichhardti* they are irregularly scattered, as in *S. ovata*. On the other hand, in *S. tasmaniensis* these bodies form one of the most characteristic surface features of the species.

In a longitudinal section, say of *S. ovata*, the acanthopores appear as fibrous strings in the walls of the corallites, and usually possess a similar fibrous structure when thickening has taken place. In some cases, although not often, the acanthopore tubes appear hollow, filled with clear calcite, and the walls strong and determinate, but these need not in any way be confounded with young corallites. It is, however, in horizontal sections, whether tangential or axial, that the structure of these bodies can be best interpreted. In sections of an entire branch, wherein both the vertical, peripheral, and axial horizontal can be studied, the acanthopores are usually visible in the latter, at the angles of the corallites, as dark bead-like spots, probably representing, as suggested by Messrs. Waagen and Wentzel, their initial stage. It is then easy to trace the relation of these bodies to the fibrous strings, or hollow tubes, as the case may be, visible in the former portion of the sections.

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[1] Genus Monticulipora, &c., 1881, p. 45.

[2] Ann. Mag. Nat. Hist., 1885, XVI, p. 497 (*note*).

[3] Die Chaetetiden der Ostbaltischen Silur-Formation, 1878, p. 9.

[4] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 871.

When acanthopores are present in unthickened corallite walls their position is usually at the angles between the corallites, but I have before me some remarkable instances both of New South Wales and Tasmanian specimens in which they are plentifully distributed along the course of the proper wall, without the latter showing the slightest trace of deposited sclerenchyma. In this position the acanthopores are separated by intervals of the wall, or are sufficiently close for their peripheries to be in contact. When in what may be termed their normal position, that is, at the angles of the corallites, the acanthopores may appear either as dark spots, in the initial stage, or as round masses of semi-transparent, fibro-concentric sclerenchyma. Those met with on the unthickened proper wall are also in this state, and sometimes, in addition, as hollow bodies occupied by a clear sparry infilling. On some highly-thickened walls the acanthopores are indicated as irregularly-distributed small openings without distinctive features, such as now lie before me in a Tasmanian *S. ovata*, and the Queensland *S. Leichhardti*. In a very instructive tangential section (Pl. VII, Fig. 8) of the last-named species, taken slightly obliquely to the surface, the acanthopores appear as definite tubes, with determinate walls passing through the substance of the thickened corallite walls.

The acanthopores, when more fully developed, are formed by similar fibro-laminar sclerenchyma to the thickened corallite walls, deposited concentrically. They appear either as depressions with a perspective concavity, or papillar eminences with a dark central spot. At times the thickened rod-like mass seems to occupy the centre of an ill-defined triangular space (same as visible in Pl. VII, Fig. 3) in the angles of the corallites, but separated from edge of the former by a minute infilling of matrix. The structure within the perspective concavity even differs, and may consist of a ring of matrix, or even secondary deposit, followed by a mass of sclerenchyma, with a dark central nucleus, or a vacuity filled with clear calcite. Another modification observed consists in the perspective cavity filled with a clear sclerenchymous deposit, itself bearing a dark spot, central or excentric. In the latter case the clear ring is not continuous all round, but, like the secondary deposit in the corallites of *S. australis*, is deficient at some part of its course. A similar instance has been figured by Messrs. Waagen and Wentzel in their *Geinitzella crassa*, Lonsd., sp.[1] A few instances have presented themselves in which the acanthopores are situated quite on the margin of an interstice, and when

[1] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 114, f. 1c.

in this position appear small, and more or less aborted. The margins of contiguous corallites, both in the unthickened and thickened condition, are often rendered uneven by the projection of the acanthopores inwards. In the first case they give to the wall a moniliform appearance, and in the second they render the inner outline of the corallite irregular, or fluctuating, and tend to still further obliterate any trace of the former polygonal outline the particular corallite may have possessed. Again, a parallel case may be seen in the figure of *Geinitzella columnaris*, Schl., sp., given by Waagen and Wentzel[1].

Messrs. Waagen and Wentzel have criticised[2] Prof. H. A. Nicholson's view that the acanthopores throughout the Monticuliporidæ are peculiarly modified corallites.[3] They regard them as newly-developed gems,[4] and remark as follows :—"The figure quoted above shows us a number of these spiniform corallites within the central portion of the colony as compact dark spots without hollows in the middle. In the same figure, however, we see more towards the peripheral region of the colony, just where the transition between the central and peripheral regions takes place, these so-called spiniform corallites opening out and transforming themselves into little tubes. These again become more and more widened, and at last become corallites of the common shape. From these observations it appears, beyond doubt, that a great part of the so-called spiniform corallites are nothing but newly-developed gems."

In the late edition of his "Palæontology," Prof. Nicholson has replied[5] to this, and I cannot do better than quote his words—"Waagen has expressed the opinion that the 'acanthopores' are only immature tubes, but this is conclusively shown to be erroneous by the fact that, while immature tubes can be readily demonstrated in *all* specimens, the 'acanthopores' are strictly confined to particular *species* of Monticuliporoids, and are uniformly absent in others. Moreover, they differ entirely in structure from the young tubes, and, unlike the corallites (whether young or old), they project above the general surface of the colony in the form of spines. Again, when they are limited in number, the acanthopores occupy definite positions as regards the ordinary tubes of the colony; and, finally, in many forms.....the acanthopores are so numerous as to render the hypothesis that they are of the nature

[1] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 112, f. 4.
[2] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 870.
[3] Genus Monticulipora, &c., 1881, p. 46.
[4] *i.e.*, young corallites.
[5] A Manual of Palæontology, &c. Third Edition. By H. A. Nicholson and R. Lydekker, 1889, I, p. 349.

of young corallites quite untenable." The strongest point in this reply seems to me to be the numerical preponderance of the acanthopores in some sections. Granting, for the sake of argument, that the acanthopores are the initial stages of new corallites—they would during growth towards maturity so entirely crowd-out and distort the corallites, already on their way to senility, as to leave traces of such an exceptional growth in some form or another. No section of a *Stenopora*, which has come under my notice, has presented any trace of such an inordinate growth of young corallites.

In transverse sections young tubes may be distinguished usually nestling at the angles of the more mature corallites, similar in structure and appearance, but usually triangular, quadrangular (oblong or rhomboid), or pentagonal. They share with the older tubes the phenomena of thickened walls, and the presence of a secondary deposit within them. Much more rarely, young tubes appear as a portion of an older corallite partitioned off by a more or less direct line. In those species in which periodic growth is frequent and rapid, a large proportion of the newly-developed corallites do not appear to reach maturity.

Reproduction in *Stenopora* takes place generally by intermural gemmation, at rare intervals by fission. The young corallites mentioned above, in the first category, are the result of intermural gemmation, which consists in a subdivision or splitting of the primary wall of one or more corallites, and the gradual production therefrom of a similar tube. Young corallites which appear in a horizontal section as partitioned off from an old one are more probably the result of fission. Fissiparity consists of a longitudinal and internal subdivision of a mature corallite, resulting in the production of two, at first within the space originally occupied by the one. Intermural gemmation can be studied with advantage in sections, and longitudinally-fractured examples of *S. crinita* and *S. ovata*, but more particularly the former (Pl. V, Fig. 2)[1]. Fissiparity has been observed in a few instances also in *S. crinita*.

The walls of *Stenopora* are imperforate, as the researches of Messrs. Waagen and Wentzel have conclusively shown. It will be remembered that the late Prof. de Koninck[2] was the earliest writer to describe perforated walls in *Stenopora*[3], in a species he referred to *S. ovata*, Lonsdale, and, in consequence,

[1] This figure has by inadvertence been reversed, giving to the new interpolated tube the appearance of proceeding downwards instead of upwards.

[2] Foss. Pal. Nouv. Galles du Sud., 1877, Pt. 3, p. 156, t. 7, f. 5 & 5*a*.

[3] De Koninck's enlargement, Fig. 5*a*, certainly represents a *Stenopora*, but the determination of Fig. 5 is very questionable. It bears a much closer resemblance to *Trachypora Wilkinsoni*, mihi.

transferred the latter to *Favosites*. Following him, Prof. H. A. Nicholson and the Writer most certainly observed pores in the coral named by us *S. Jackii*[1], and believed them to exist in *S. ovata*, nobis (non Lonsdale). In our later researches, however, embracing a review of all the Australian species, our views with regard to the perforation of the walls in *Stenopora* were much modified, but we were still perplexed by the occasional appearance of rounded apertures in longitudinal sections, both of *S. ovata*, Lonsdale, and *S. australis*, nobis, which were probably of this nature. In consequence of this we wrote as follows:—"The marked resemblances between the *Stenopora* and certain of the Monticuliporoids has led us to think that too great weight has, perhaps, been attached by De Koninck, as also by ourselves, to the value of the "mural pores" as a character of classificatory value. There can be no doubt that the walls of the corallites in some (and probably in all) of the species of *Stenoporæ* are pierced by irregular mural pores, and hence we have formerly referred the genus to the Favositidæ. In all other points except this, the species of *Stenopora* are, however, most nearly related to the Monticuliporoids. . . ."[2]

It would certainly appear from the careful later researches of Messrs. Waagen and Wentzel that the presence of pores in *Stenopora*, in the sense in which they are generally employed in the Favositidæ, cannot be upheld, and both Prof. Nicholson[3] and the Writer are prepared to abandon these structures as a distinguishing feature of the genus, leaving to future researches to determine the occasional appearance of mural openings in the species mentioned above, and their regular occurrence in *Stenopora Jackii*. An examination of the fine series of *S. crinita* in the Mining and Geological Museum has convinced me that the walls of this species are also imperforate—in fact, it was the thorough investigation I was able to give this species that brought home to me the general accuracy of Messrs. Waagen and Wentzel's observations.

These authors explain the rounded apertures observed by Prof. H. A. Nicholson and the Writer by supposing them to be, when seen in longitudinal sections, "the transverse section of some of those protuberances which have been called rudimentary septa in the Favositidæ or Chætitidæ." To this I cannot subscribe, never having seen the least trace of septal spines, or other mural development resembling them, in any species of

[1] Ann. Mag. Nat. Hist., 1879, IV, pp. 270 and 275.

[2] Ann. Mag. Nat. Hist., 1886. XVII, p. 174.

[3] Letter dated June 4th, 1888. (Also see of Palæontology, 1889, I, p. 357.)

Stenopora examined. As regards their figure,[1] to which these observers refer in confirmation of their opinion, the openings there represented seem much too irregularly distributed for septal spines, and do conform to the irregular arrangement assumed by the supposed pores in the species before mentioned. Neither septa nor pseudo-septa have revealed themselves in any section of *Stenopora* examined by me.

Tabulæ in the Australian forms of *Stenopora* appear to follow two well-established rules. In the axial region they are few in number, and remote; in the peripheral zone, either numerous and close, or comparatively absent. In *Stenopora crinita* one of these terms is hardly applicable, for we are not acquainted with a peripheral region in this species, in the same sense as in the others, but should rather speak of an axial region and periodic growth stage. In the former tabulæ are certainly remote, but are placed at the same level in contiguous tubes, corresponding to the distant fusiform thickenings and accompanying constrictions. At the termination of the latter the tabulæ increase greatly in number, corresponding to the more frequent thickenings; and probably, could we obtain a perfect example, it would be found that tabulæ occurred at all of these points in *S. crinita*.

In *Stenopora ovata*, *S. tasmaniensis*, and *S. australis* the tabulæ of the axial region follow the structure described in *S. crinita*, except that they are usually single and scattered. In *S. Leichhardti*, I am not acquainted with axial tabulæ, and only in the peripheral zone in the figure given by Prof. Nicholson and the Writer.[2] It is clear that tabulæ are very rare in this species, but whether structurally so, or from its peculiar state of preservation, I am not in a position to say. In the latter portion of the corallum in *S. ovata*, and probably also in that of *S. australis*, the tabulæ occur in such well-preserved examples as the Tasmanian specimens, frequently at the points of constriction, and on the same level with one another. But in the case of the former species caution must be exercised so as not to confound the true tabulæ with the foldings of sclerenchyma previously mentioned, which occur in the corallites of this species. Lastly, in *S. tasmaniensis*, the massively-thickened condition of the peripheral layer of the corallum renders a view of the tabulæ almost impossible. It is, however, probable that they are closely packed together.

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[1] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Pt. 6, t. 111, f. 1c.

[2] Ann. Mag. Nat. Hist., 1886 XVII, t. 3, f. 8.

The tabulæ of the Australian species appear to me to be undoubtedly complete, and their concavity is downwards. I have never seen an instance of a perforated tabula in the proper sense of the word, and I believed that the supposed incomplete tabulæ seen by Prof. Nicholson and the Writer in *S. australis*[1] are capable of explanation, by regarding the secondary infilling of the tubes in this and other species as of *post-mortem* origin, or, at any rate, accumulated under exceptional circumstances. Under the specific description of *S. tasmaniensis* it will be explained that the final closure of the mouths of the corallites cannot be explained in the sense of perforated tabulæ. The misconception which may arise in connection with the closure of tubes by the zooids at the final period of growth is well explained by a study of the tube infillings of *Stenopora crinita* (Pl. III, Fig. 6; Pl. VI, Fig. 3). Many of the tubes would, on a superficial examination, be pronounced as so closed, but the structure here exhibited arises from a regular concentric deposit of mammillated or concentrically-laminated carbonate of lime, with the edges of the layers cut across. A longitudinal view of the deposit in the corallites of the same species further explains its phenomenon (Pl. VII, Fig. 1.)

In the article last referred to we pointed out how these supposed perforated tabulæ differed from the undoubted structures of this nature in *Stenopora Howsei*, Nich., in which the tabulæ are very numerous, bearing central apertures quite apparent in long sections. It is probably for a similar coral that Mr. John Young[2] has proposed the generic name of *Tabulipora*, but, excepting the structure of its tabulæ, it agrees in every way with that of *Stenopora*. We have already explained[3] that "if no other species of *Stenopora* possessed perforated tabulæ there would be ground for accepting *Tabulipora* as a sub-genus of *Stenopora*, or, perhaps, as a distinct genus." The view here adopted of the tube infillings of *S. australis*, and the final closure of the mouth in *S. tasmaniensis*, will remove the doubts hitherto existing as to the validity of *Tabulipora*, which must be restored to its place as a distinct and separate genus.

The nearest allies of the genus *Stenopora* are *Geinitzella*, and the above-mentioned *Tabulipora*. The distinction between the first and the last of these genera has just been indicated. That between *Geinitzella* and *Stenopora* appears to me to rest on a very slender basis, and to require further

[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 176.
[2] Ann. Mag. Nat. Hist., 1883, XII, p. 154.
[3] Ann. Mag. Nat. Hist., 1886, XVII, p. 177.

investigation. Messrs. Waagen and Wentzel, the describers of the genus[1], appear to rely for the separation of it by the absence of "the strong periodical thickenings of the walls of the corallites, so very conspicuous in Stenopora," and by "transverse wrinkles which are chiefly conspicuous on the internal casts." If I correctly understand these authors, this separation seems to me a very artificial one, and for two simple reasons:—1st. Periodical thickenings are absent in at least one presumed species of *Stenopora*, viz., *S. Leichhardti*, so far as we at present know its structure, the formation of the walls in this particular coinciding completely with that of their *Geinitzella*; they are confluent in the peripheral region of *S. tasmaniensis*, and frequently approach this condition in *S. ovata*. 2nd. A transverse wrinkling is present on the internal surface of most species of *Stenopora*, and has been referred to more than once in preceding pages; and, unless I wholly misunderstand Messrs. Waagen and Wentzel's meaning, it is conspicuous in their own figures of *Stenopora*.

With regard to the range of the genus in time and space, if we eliminate *S. Howsei* as referable to *Tabulipora*, and accept *Geinitzella*, *Stenopora* is found only in Australia, Tasmania, and India. On the other hand, by retaining the first-named species in the genus, the range of the latter is extended to the Carboniferous rocks of Great Britain; and if *Geinitzella* cannot be satisfactorily separated from *Stenopora*, then its appearance in the Russian Permian rocks is assured. If *Geinitzella* be considered distinct, the geographical range cannot be extended to Europe. In the two first-named countries it is restricted to the Marine Series of the Permo-Carboniferous, whilst in India *Stenopora* is characteristic of the Productus-Limestones of the Salt Range Series. *Geinitzella* is confined to the latter horizon and the Permian. Whichever of the above views be ultimately adopted, *Stenopora* must be regarded as a genus having strong Permian affinities, and is one of those organisms relied on for establishing the close relation believed to exist between that formation and the uppermost Palæozoic marine beds of Eastern Australia and Tasmania.

Some confusion appears to exist in connection with the species believed to exist in New South Wales. I am acquainted with three which have been described by former Writers—*S. ovata*, *S. tasmaniensis*, and *S. crinita*—but I have failed to identify *Stenopora gracilis*, Dana.[2] Prof. De Koninck described

[1] Pal. Indica, Salt Range Fossils, 1886, vol. I, Part 6, p. 880.

[2] *Chætetes*, Wilkes' U. S. Explor. Exped., 1849, Vol. X, Geology, p. 712, Atlas, t. 11, f. 10.

a branching coral from Glen William and Burragood, which he referred to *S. ovata*, but the presence of pores induced him to place it in *Favosites*.[1] This has already been explained, and will be referred to again later.

It is possible, and even probable, that all the species which have been described from Australasia do not represent separate and distinct organisms—I am inclined to think they do not—but this much is certain, they do represent different conditions, which, so far as the specimens themselves are concerned, seem permanent within certain circumscribed areas, and, therefore, for all reasonable purposes, such specimens may be considered distinct, until actual demonstration shall prove the identity of any one with another. For instance, *Stenopora ovata*, Lonsdale, and *S. australis*, N. & E., are, to all intents and purposes, identical in general characters, but the former is known to possess acanthopores, the latter not; the peculiarity in this case being that no specimen of *S. australis*, so far examined from the Bowen River Coal-field, the only locality known for this coral, has been observed to possess acanthopores—yet, in the mind of the Writer, the two "species" seem to be one.

Australian type—Stenopora crinita, Lonsdale.

Stenopora crinita, *Lonsdale.*

Pl. II; Pl. III; Pl. IV, Fig. 2; Pl. V, Figs. 1–4; Pl. VI, Figs. 3–6; Pl. VII, Fig. 1 and ? Fig. 2.

Stenopora crinita, Lonsdale in Strzelecki, Phys. Descrip. N. S. Wales, &c., 1845, pp. 91 and 265, t. 8, f. 5 and 5*a*.

Stenopora crinita, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 226.

Chætetes crinitus, Dana in Wilkes' U. S. Explor. Exped., 1849, X, (Geology), p. 711, Atlas, t. 11, f. 7.

Stenopora crinita, Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, p. 182, t. 4, f. 1-5, p. 183, f. 2.

Stenopora crinita, Johnston, Geol. Tasmania, 1888, t. 21, f. 1, 1*a*. (Copied from Lonsdale.)

Sp. Char.—Corallum massive, globose or hemispherical, sometimes becoming gibbously lobate, with an undulating mammillated surface, composed of long corallites which radiate outwards gently towards the surface, and when seen in fractured sections present a plumose appearance, which is

[1] Pal. Foss. Nouv. Galles du Sud., 1877, Part 3, p. 156.

only broken by the series of strata into which the corallum is horizontally split up. In the axial region the corallites are basaltiform, but in the peripheral area more or less polygonal, or subpolygonal; in the former with occasional constrictions at long intervals, and in both transversely undulated with narrow periodic thickenings, as they approach each final period of growth. Average diameter of the corallites about half a millimeter. Periodical thickenings of the walls are narrow, ring-like annulations, comparatively wide apart, and separated by unthickened internodes, giving to longitudinal sections of the wall a characteristically moniliform aspect; but they appear to be most abundant and closer in the outer or peripheral zone. Acanthopores, as a rule, only developed in the thickened portions of the walls, usually at the angles of junction of the corallites, but occasionally in other parts of the former. Tabulæ very sparsely developed in the axial region, but comparatively numerous in the peripheral region, corresponding in general with the thickened annulations; they are complete and imperforate, and concave in a contrary direction to the growth of the corallites. Surface undulating, bearing monticules.

Obs.—The type specimen of this species is a mass about four inches and a half in length, composed of long basaltiform corallites, with a very gentle outward inclination, and evidently taken from the axial portion of a very large corallum. This specimen is now in the Geological Department of the Natural History Branch of the British Museum.

The corallum of *Stenopora crinita* at times undoubtedly attained to a very large size; large masses, to the naked eye, having a wonderful resemblance to the large *Chætetes radians*, Fischer, of the Russian Carboniferous Limestone. Dana mentions[1] a specimen of *S. crinita* six inches in diameter. A similar one to this is in the Collection, and another five inches in diameter. The corallum is invariably large, forming hemispherical, globose, massively tabular expansions, with an undulating surface, at times rising into lobate extensions, and almost becoming digito-palmate, but, so far as known, never ramose. Irregularities in growth sometimes occur, but the coral appears to have possessed a great facility for recovering the direction of its growth. The corallites are sometimes deflected from their course, immediately above a periodical cessation of activity, represented by the moniliform constrictions; but the original line or direction of growth is almost always recovered.

[1] Wilkes' U. S. Explor. Exped., 1849, Vol. X, Geology, p. 711.

The surface of a corallum, representing its absolutely final period of growth, has not been observed, but the outline was certainly undulating, and was in all probability covered with "monticules." The present surface (Pl. II, Fig. 1) of a fine radiating mass most distinctly shows these (Pl. 5, Fig.1), and it is not improbable that this character led Prof. F. M'Coy to describe *S. crinita* as with a "mammillated surface like that of the *Ceriopora verrucosa* Goldf.)."[1])

The monticules measure, as a rule, about two lines in diameter, and are separated from one another by the same distance, or even three lines. The corallites composing them do not appear to materially differ from the others in size. It may be that the groups of corallites of smaller size, described by Prof. Nicholson and the Writer as seen at tolerably regular intervals in sections, may be those corresponding to the monticules at the surface.

The growth of the corallum was periodic, even from its youngest stages (Pl. III, Fig. 1). Indeed, this appears to be a character incidental to the whole group of *Stenoporæ*, but is particularly characteristic of this species. The entire corallum is stratified in layers of very regular thickness (Pl. II, Figs. 1 and 2), a feature excellently shown in Lonsdale's original figure,[2] and referred to by Dana in the following words:—"They" (*i. e.*, the corallites) "separate rather easily, and are singularly regular in form, with few constrictions from irregular growth, and these commonly very slight, and in concentric lines, which sometimes give a specimen the appearance of being made of successive tiers of columns."[3]

The strata in *S. crinita* vary from three to ten millimetres in height, and so marked a feature is this stratification that, unless great care be taken, specimens in the slightest degree weathered break up along these planes. It is possible in certain states of preservation to peel off the strata, corallite by corallite, leaving an entirely new surface exposed after each operation. *Stenopora crinita* was, in all probability, attached by the whole of the base (Pl. III, Figs. 1 and 2), that is to say, the object which any individual particularly favoured was entirely coated or surrounded by it. The specimen represented in Pl. III, Fig. 1, has selected a *Streblopteria*, and has spread out from that in a concentrically circular manner, stratum upon stratum, until a base has been produced differing little in general appearance from some Favositoid corals. Other specimens in the Collection have attached themselves to univalve shells, and completely invested them.

[1] Ann. Mag. Nat. Hist., 1847, XX, p. 226.
[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 5.
[3] Wilkes' U. S. Explor. Exped., 1849, Vol. X (Geology), p. 711.

The average diameter of the corallites is about half a millimetre; they are polygonal in the peripheral region, basaltiform in the axial portion, and possibly not in close contact throughout. The external aspect of the corallites in fractured specimens is very characteristic. The first point to strike the eye is the basaltiform outline, with the gradual appearance of crenulations, or moniliform swellings, as the upper surface of each successive stratum or colony is approached (Pl. II, Figs. 1 and 2). This applies to the tubes whether in the peripheral or axial region, it being a mistake to suppose that these are confined in a greater degree to the former area. In the axial region, however, the annulations are not seen in the central portion of an internode, but only at the final period of growth, but generally when the internodes are long the annulations are single, as originally figured by Lonsdale, or at the most two or three. At the terminal stage in each colony, like those in the peripheral area, they become closely contiguous, and are specially numerous when the strata are short. In Pl. V, Fig. 3, are represented two corallites, viewed from the interior, in which the thickened ring, giving rise to a moniliform expansion, is plainly visible.

The primordial wall, or test, must have been very thin, shelling off in our fractured specimens as a thin pellicle.

As already explained in the generic description, the tubes do not appear to have been in absolute contact throughout, but a very thin space seems to exist between them. In Pl. V, Fig. 4, this is illustrated, the black central infilling between contiguous corallites being the separating medium, bounded by the lighter-coloured walls of the tubes, and the cavities of the latter again filled with darker matrix.

No better illustration of the variability in the thickness of the walls in *Stenopora* can be afforded than in the structure of the present species. Here the width of the walls varies according as the plane of the section corresponds with the thickened nodes, or traverses the unthickened internodes. In Pl. VI, Fig. 4, the abrupt passage from one to the other is clearly shown, but in many specimens the entire absence of nodes is a marked feature. In the majority of examples of *S. crinita* the thin proper walls of the corallites are usually lined by a continuous investment of calcareous substance, in this particular instance brown, of variable but usually considerable thickness. This investment is so invariably present, is so constant within

certain limits in its thickness, and so exceedingly regular in its development that it possesses every feature presented by the layer of secondary sclerenchyma which is deposited on the inside of the proper wall of *Pachypora*, *Laceripora*, and other similar corals.

This secondary deposit is invariably similar in every corallite of an individual specimen, both in character and amount. In one specimen it may be of considerable width, and very dark in colour; in another narrow and pale, but there is no commingling of the two kinds. The smallest intercalated tubes follow the same rule. It is carried to the greatest extent, throughout the suite of specimens examined by me, in one from Singleton, wherein the tubes are all but choked up by it, leaving only the smallest particle of clear crystalline calcite in the centre. The investing nature of this deposit cannot be better studied than in transverse sections (Pl. III, Fig. 6), when it appears as a vertical crust completely lining the proper walls of each corallite. When *S. crinita* is devoid of this secondary deposit, the tube walls are very uniform in appearance, clear and distinct, forming a remarkably regular and constant network. Touching the nature of this deposit, the following is the conclusion of Prof. Nicholson and the Writer:—"This curious investment, in spite of its extraordinarily regular development, is of inorganic origin, and is produced by a *post-mortem* deposition of carbonate of lime within the cavities of the tubes. We have been led to this conclusion principally by two considerations. In the first place, we found that in one specimen of *S. crinita*, as above described, this secondary lining of the tubes had no existence at all. In the second place, we found that in another specimen of the same species this singular brown lining was present, but was irregular in its development, terminating in a ragged free edge where it surrounded the visceral chamber."[1] In Pl. III, Fig. 6, this infilling investment is exceedingly well shown from a calcareous and naturally-weathered specimen. On the upper left and towards the lower centre of the figure four corallites will be noticeable as nearly completely closed.

Well-marked acanthopores are at times placed at the angles of junction of the corallites, but their presence is by no means regular. They are sometimes minute, but at other times large, circular, thick-walled, and showing a distinct lumen. In the type specimen in London they are plainly visible in all the sections made, but in a number of the specimens contained in our Collection their presence is uncertain, although at times they can be detected.

[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 184.

In some specimens, here and there, at tolerably regular intervals, may be observed groups of comparatively small-sized corallites, with thicker walls and larger acanthopores. An explanation of this has already been offered on a previous page.

The presence of tabulæ is an equally variable feature with the acanthopores in *S. crinita*. They are developed from the nodal points, sometimes very few, or none, being present in one set of tubes, whilst, on the other hand, they may be developed from almost every successive pair of nodal points in another series. Furthermore, the tabulæ appear to be complete (Pl. VI, Fig. 6, Pl. VII, Fig. 1.)

The chief specific points which may be employed for the determination of *Stenopora crinita* are—1. Its massive rounded and lobate outline; 2. The highly stratified mode of growth, whether in the axial or peripheral regions; 3. The presence of long internodes between the moniliform swellings, as compared with those of other species; 4. Complete and imperforate tabulæ; 5. Presence of monticules; 6. Acanthopores, when present, developed at the angles of the corallites, rarely elsewhere.

Some doubt has hitherto existed in the minds both of Prof. H. A. Nicholson and the Writer[1] regarding the specific value of *Stenopora informis*, Lonsdale.[2] Only two specimens are known to me, which can, with any possible certainty, be referred to this coral—the type in the British Museum, London; the other a very beautiful fragment from near Hobart, Tasmania, presented by Mr. John Waterhouse, M.A. The moniliform annulations are so strongly marked, as close set rings placed invariably at corresponding levels throughout the corallum, added to the fact that a marked difference exists in the size of the corallites—one-third millimetre in the case of *S. informis*, and one-half millimetre in *S. crinita*—that it is still necessary, in the absence of further details, to retain the species separate. The height of the Tasmanian specimen referred to is one inch, and throughout this extent the swellings are crowded together with the greatest compactness, but still retaining their perfect outline and shape. They are much more distinct and regular than those of *S. crinita*, and throughout the specimen do not show any of the comparatively long internodes of that species. Is it possible that we have here the final period of growth of *S. crinita*?

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[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 181.

[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 4 & 4*a*.

Locality[1] *and Horizon.*—Hunter River Railway Bridge, Singleton, Co. Durham (*Messrs. T. W. E. David, B.A.*, and *S. Dodds*); Bow-wow, Mount Vincent, Co. Northumberland (*T. W. E. David, B.A.*); Shoalhaven, Co. St. Vincent (*C. Cullen*); Creek half-a-mile south-west of Dapto, Co. Camden (*C. Cullen*); Railway cutting under Wollongong Road, Wollongong, Co. Camden (*S. Alexander*); Coast, about one mile south of Jerringong, near Kiama, Co. Camden (*E. C. Whittle*) :—**Upper Marine Series.**

Stenopora ovata, *Lonsdale.*[2]

Pl. V, Figs. 5 and 6; Pl. VI, Figs. 7 and 8; Pl. VII, Figs. 3-6.

Stenopora ovata, Lonsdale, in Darwin's Geol. Obs. Volc. Islands, 1844, p. 163.

Stenopara ovata, Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 263, t. 8, f. 3–3*b*.

Stenopora ovata, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 226.

Chætetes ovata, Dana, in Wilkes' U. S. Explor. Exped., 1849, Vol. X, Geology, p. 712, Atlas, t. 11, f. 9, 9*a* & *b*

Stenopora tasmaniensis, Nicholson, Tab. Corals, Pal. Period, 1879, p. 281, f. 3 A & B.

Stenopora ovata, Nicholson and Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, p. 173, t. 3, f. 1–4.

? *Stenopora ovata*, Waagen and Wentzel, Pal. Indica, Salt Range Fossils, 1886, Vol. I, Pt. 6, p. 888, Atlas, t. 110, f. 1–3.

Stenopora ovata, Johnston, Geol. Tasmania, 1888, t. 21, f. 4, 4*a*. (Copied from Lonsdale.)

Sp. Char.—Corallum large, ramose, spreading dichotomously; branches cylindrical or sub-compressed, from a quarter to one inch in diameter, decreasing in size but little towards their apices; stratification usually visible only in the peripheral zone. Corallites polygonal in the axial region, becoming cylindrical in the peripheral area, the angle of deflection being sharply marked, at times almost becoming a right angle; viewed transversely the corallites are long-oval, rounded, or sub-polygonal, from one-third to half a millimetre in diameter. Periodical annulations absent in the axial region; numerous, close-set, and sub-pyriform in the outer zone, but when this zone is much extended becoming confluent.

[1] By Count P. de Strzelecki, *S. crinita* was recorded from Illawarra, in limestone (Phys. Descrip., N. S. Wales, 1849, p. 91); by Prof. F. M'Coy from Wollongong, in sandstone, Darlington, in sandstone, and Black Head, Illawarra, in calcareous beds (Ann. Mag. Nat. Hist., 1847, XX, p. 226); and by Prof. J. D. Dana, at Wollongong Point, Illawarra (Wilkes' U. S. Explor. Exped., Vol. X, 1849, Geology, p. 711).

[2] Non *Stenopora ovata*, Nicholson and Etheridge, Junr., Ann. Mag. Nat. Hist., 1879, IV, p. 274.

Primordial wall distinct, delicate, sometimes becoming thickened. Acanthopores usually developed at the angles of junction of the corallites, and when so few in number, of large size, and forming blunt spines at the surface; at times greatly developed in the thickened portions of the walls, when their situation is variable. Tabulæ complete, few, and remote, in the axial region; becoming closer in the peripheral zone.

Obs.—The type specimen of *S. ovata*, like that of *S. crinita*, is preserved in the Geological Department of the British Museum—that is to say, the specimen which must be regarded as the type—for the original coral on which Lonsdale founded the name, and collected by the late Dr. Charles Darwin, has been lost in the passage of time—is retained therein, and is that figured by Lonsdale in Strzelecki's work.

The corallum is dichotomously branched, and must have attained some size, as the type measures four inches in length, and is clearly only a portion of a much larger example. Individual branches retain their size throughout, very little diminution in diameter taking place towards their apices, and thus giving to the corallum a marked and probably specific appearance. Branches have been observed as small as a quarter of an inch, and as large as an inch in diameter, with the apices blunt and rounded, but examples with the axial region removed, leaving a hollow cylinder represented by the peripheral zone, have not come under notice, except from Tasmania.

As might be expected from its mode of growth, stratification, as a rule, does not take place in the axial region, nor to any extent in the outer zone, in our New South Wales specimens until the periphery is approached. The figured type does, it is perfectly true, as in all Tasmanian examples I have seen, show such demarcation in layers in the central zone.

Nothing is known of the mode of attachment in this species, but judging from analogy, the base will probably be found to be encrusting rather than enveloping.

The persistent manner in which the matrix invariably adheres has rendered it almost impossible to observe the surface characters at a final period of growth. On one coral from Singleton, however, the mouths of the corallites are either round or polygonal, and the cell walls rather more thickened than when seen in transverse sections of the peripheral region. Neither monticules, nor clusters of smaller cells, have been noticed. The interstitial, or inter-calicular surface, is always large in this species.

The corallites, after their divergence from the axial region, lose much of their polygonal form, and become to some extent cylindrical. The preservation of the proper wall and line of demarcation between the corallites varies much according to preservation, but, as a rule, they can be satisfactorily made out. In an exceptionally good section of this species may be seen the primordial wall, the secondary organic thickening, and the inorganic investment (Pl. VII, Fig. 3). There is but little difference in a transverse axial section between this species and *S. crinita*, excepting in the size of the corallites; there is the same form, same condition of the walls, and the same secondary inorganic deposition around the walls. In a transverse section of the peripheral region the periodical thickenings succeed one another more rapidly in succession, and they are more strictly moniliform, or even pyriform, than in *S. crinita*. It is, however, in a longitudinal axial section that the greatest differences are observable, the corallites of *S. ovata* so far examined by me being here entirely destitute of constrictions or swellings, and are practically non-tabulate also. The moniliform swellings of the walls vary to some extent from being moderately distant[1], to a rapid succession of one another, and they are at times semi-confluent, more especially in Tasmanian examples, but in such cases do not entirely lose their moniliform outline, as in the case with *S. tasmaniensis*.

In Pl. VII, Figs. 2 and 3, the insensible manner in which the original wall passes into a thickened portion, and becomes lost, is excellently shown, but now and then it can be equally distinctly traced in the latter.

In position and structure the acanthopores (Pl. VII, Figs. 2 and 4) are very similar to those of *S. crinita*, and when present usually occupy the angles between contiguous cells; but at times, especially in Tasmanian examples, are scattered on the intermediate boundary walls rather thickly, although never clustered there as in *S. tasmaniensis*. They are circular, very strongly-developed and with thickened walls, and a distinct lumen. In a very interesting section (Pl. VII, Fig. 3), from a Singleton specimen, there is an instance of the development of acanthopores in thickened and unthickened walls, side by side; and, lastly, the central aperture usually occupies a very large part of the diameter. They have a general papillose appearance, the walls being concentric-laminar in structure. In vertical sections the acanthopores appear as rods running in the corallite walls, and in this species are very persistent.

[1] Ann. Mag. Nat. Hist., 1886, XVII t. 3, f. 2.

The tabulæ are complete, making their appearance soon after deflection of the tubes from the axial region, and gradually increasing in number and contiguity to one another as the surface is approached.

The chief points for specific determination are—1. The dichotomous method of branching; 2. The almost invariable presence of a large acanthopore at most of the angles of junction of the corallites, a character specially dwelt on by Lonsdale,[1] who mentions that there is only one "relatively large tubercle" in the "interspaces between four mouths"; 3. The absence of tabulæ in the axial region.

Amongst the synonyms of *Stenopora ovata* generally given by authors is the *Favosites ovata*, De Koninck.[2] The fossil there described as possessing pores cannot be accepted as a *Stenopora*, and as regards the figures there must be an error. De Koninck's Fig. 5 of the plate cited below represents corallites at least twice too large for those of *S. ovata*, but, on the other hand, Fig. 5*a*, said to be an enlargement of the former, distinctly shows moniliform expansions of the walls, after the manner of that species. Fig. 5, on the contrary, has far more the appearance of *Trachypora Wilkinsoni*, mihi, and the presence of pores will then be quite in accord with the structure of the latter; at the same time, the walls of the corallites are not annulated. As so much doubt, therefore, surrounds the identity of this fossil, I have not included it in the synonomy of *Stenopora ovata*.

In the beautiful figures of this species given by Messrs. Waagen and Wentzel the moniliform annulations are in places confluent. As previously stated, I have not observed this in any New South Wales, although it is apparent in Tasmanian examples; but, otherwise, the Indian form appears to coincide with that from our rocks.

A re-examination of the form called by Prof. Nicholson and the Writer *S. Leichhardti*[3] has shaken the Writer's faith in the distinctness of this as a species, and it may have to be referred to *S. ovata*. The chief point of difference relied on for their separation was the greater prevalence of acanthopores and their larger size in the former species, the long fusiform, and at times almost confluent periodical thickenings, and the very simple tube-like nature of the acanthopores. The examination of additional material

[1] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 264.

[2] Foss. Pal. Nouv. Galles du Sud, 1877, p. 156, Pt. III, t. 7, f. 5, 5[a].

[3] Ann. Mag. Nat. Hist., 1886, XVII, p. 179. t. 3, f. 7 and 8.

of the latter species, especially from Tasmania, received through the courtesy of Mr. R. M. Johnston, F.L.S., seems to indicate that the fossils known under these names should be united. Anticipating other specimens of *S. Leichhardti* from Queensland for examination, this step is deferred pending such.

In our paper[1] "On the Tasmanian and Australian Species of the Genus *Stenopora*," Prof. H. A. Nicholson and the Writer referred to Tasmanian *Stenoporæ* having the general characters of *S. ovata* and *S. tasmaniensis*, but with a compressed corallum, the corallites radiating from both sides of a central plane. Mr. R. M. Johnston has forwarded me similar specimens from Porter's Bay, near Hobart, and Maria Island, respectively. That from the latter locality, and one example from the former, are certainly frondescent, *i.e.*, forming flattened tabular expansions of irregular form, as the specimens now lie on the surface of the matrix. Certain of the remainder from Porter's Bay exhibit the true characters of *S. ovata*, although a good deal compressed, but it is clear that they are simply compressed stems. On the other hand, a larger specimen resembling the latter in its general features may have a frondescent corallum, but its present exposure from the surrounding matrix is not sufficient to enable me to form a decided opinion. We may, therefore, conclude, tentatively, that there is the possibility of both *S. ovata* and *S. tasmaniensis* possessing an allied species in which the microscopic structure is very similar, but with a frondescent corallum. This point only future research can decide. Had it not been for corallites opening on both sides of a central plane, without definite signs of compression, I should have suggested the possibility of this being the base of attachment of *S. ovata*, but of course that one fact is fatal to such an idea, on the supposition of the base being encrusting. I am under the impression that the form resembling *S. tasmaniensis* will require to be separated from that species, and should investigations, now in progress on the structure of the Tasmanian *Stenoporæ*, confirm this supposition, I shall have much pleasure in calling it *Stenopora Johnstoni*.

This fossil, of course, brings forward the important question of how far outward form can be depended on for specific determination. To a certain extent there is no doubt it can—thus, the growth of *S. crinita* is in itself distinctive, as between it and other species, except *S. informis*, if this be a

[1] Ann. Mag. Nat. Hist., 1886, XVII, pp. 175 & 179.

species. The ramose characters of *S. australis*, *S. ovata*, and *S. Leichhardti* are sufficiently marked to distinguish them from *S. tasmaniensis*, whilst the frondescent condition of the fossil above referred to, from Tasmania, is unlike any of the other Australian *Stenoporæ*.

Locality[1] *and Horizon.*—Hunter River Railway Bridge, Singleton, Co. Durham (*T. W. E. David, B.A.*); Maitland Vale, near West Maitland, Co. Durham (*R. W. Thompson, M.P.*):—**Upper Marine Series.**

Stenopora tasmaniensis, *Lonsdale*[2].

Pl. IV, Figs. 3 and 4; Pl. V, Figs. 7 and 8; Pl. VII, Fig. 9.

Stenopora tasmaniensis, Lonsdale, in Darwin's Geol. Obs. Volc. Islands, 1844, p. 161.

Stenopora tasmaniensis, Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 262, t. 8, f. 2–2.

Stenopora tasmaniensis, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 226.

Chætetes tasmaniensis, Dana in Wilkes' U. S. Explor. Exped., 1849, X (Geology), p. 711, Atlas, t. 11, f. 7–8*a*.

Stenopora tasmaniensis, Nicholson and Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, p. 178, t. 3, f. 9–12.

Stenopora tasmaniensis, Johnston, Geol. Tasmania, 1888, t. 21, f. 3–3*b*. (Copied from Lonsdale.)

(Compare *S. gracilis*, Dana, *Loc. cit.*, p. 712, t. 10, f. 15, *a–c*.)

Sp. Char.—Corallum dichotomously ramose, varying from three to eleven-sixteenths of an inch in diameter; branches cylindrical, but frequently swelling and decreasing in size during their course, especially towards their apices, sometimes contorted; peripheral portion of the corallum very narrow and much reduced, the axial region being correspondingly wide. Corallites deflected from the axial line at a very low angle, bending gradually and slowly outwards, polygonal in the axial region, becoming more cylindrical towards the periphery; calices oval, about one-third millimetre in diameter, disposed in slightly oblique rows, giving rise to a quincuncial arrangement, their longer axis corresponding with the long axis of the

[1] *Stenopora ovata* was first recorded as a New South Wales fossil by M'Coy, simply with the remark—ommon in Darlington Sandstone (Ann. Mag. Nat. Hist., 1847, XX, p. 226); Dana next noted its occurrence at Harper's Hill, near West Maitland (Wilkes' U. S. Explor. Exped., Vol. X, 1849, Geology, p. 712); and the late Rev. W. B. Clarke gave Singleton Bridge as a third locality (Sed. Form. N. S. Wales, 4th Edit., 1878, p. 135).

[2] Non *Stenopora tasmaniensis*, Nicholson, Tab. Corals Pal. Period, 1879, p. 281, f. 38.

corallum; vestibules deep; interstitial surfaces strongly angular. Acanthopores small, very numerous, forming a more or less complete ring round each calice, and placed on the angular interstitial surface, superficially appearing as oblique rows, or encircling rings of small tubercles, or minute apertures. Moniliform annulations, or periodical thickenings of the walls confined to the peripheral region, wide, and generally confluent towards the final period of growth, and thus becoming comparatively individually indistinct when separate, presenting an obconate appearance in sections. Tabulæ very sparingly developed, complete, but the calices sometimes closed by perforated diaphragms.

Obs.—In the case of this species identification has chiefly depended on Lonsdale's figure in Strzelecki's work, but the characters are so well marked that little difficulty has arisen in referring specimens to it. The figured example could not be found in the Department of Geology, British Museum, by the Writer.

As in *S. ovata*, the corallum is dichotomously branched, but, on the whole, *S. tasmaniensis* must be regarded as a less robust species than the form just named. The branches are sometimes enlarged and constricted in their course, and it not infrequently happens that the apices are hollow, from the apparent decay or disintegration of the corallites in the axial region. Lonsdale noticed[1] this peculiarity, and both he and Dana speak of specimens crushed completely flat, with the whole of the axial portion removed. The base of attachment has not been observed, at the same time the species attained some size, as Lonsdale mentions one four and a half inches in length.

As distinguished from *S. ovata* and *S. Leichhardti*, the peripheral region in the species now under description is remarkably narrow, arising chiefly from the very gentle angle at which the tubes diverge from the imaginary axis, the strong angle of deflection visible in other species being quite absent.

The corallites in the axial region are angular, but become cylindrical throughout their short peripheral course. The primordial wall is visible in the former, and throughout a considerable portion of the latter, as very little secondary organic thickening appears to have taken place until the periphery of the corallum is approached. It is rare to meet with moniliform

[1] Darwin's Geol. Obs. Volc. Islands, 1844, p. 161.

annulations except towards the final period of growth of the corallum where they are confluent and continuous with one another, not separated by marked unthickened segments, but forming a dense thickened peripheral layer along individual walls, presenting an obconate figure in section, which is very characteristic of the species. Annulations have been observed below this, and even one or two in the axial region, but these occurrences are rare. Sometimes the first, or the two first, in ascending order in the peripheral area, are separate, and distinctly formed; then succeeds the line of amalgamated annulations nearly continuous with one another.[1] The inorganic deposit, which forms such a prominent feature in *S. crinita* and *S. ovata*, is not developed to an extent in any way approaching that seen in those species, and at times is barely perceptible at all. In a Tasmanian specimen from One Tree Point it is entirely absent.

The surface features of *Stenopora tasmaniensis* are very characteristic of it. In a recent Memoir, Prof. Nicholson and the Writer pointed out that this species can be at once recognised amongst the other Australian forms by its long oval calices arranged in obliquely longitudinal rows, resulting in a quincuncial disposition of the apertures. The thickening previously described at the final period of growth along the line of close-set annulations extends to the outer surface, the calices being separated from one another by crestiform interstitial surfaces. The vestibules[2] of the calices are straight-walled or funnel-shaped, according to the development of the diaphragms which appear to close those of *S. tasmaniensis* at the final period of growth.

This partial closing of the tube mouths at maturity has been well described and figured by Lonsdale.[3] He says, "Where the mouth becomes free and oval, the walls are thin and sharp, and perpendicular within the tube. In some cases they are in contact; but in others they are separated by grooves of variable dimensions, in which very minute foramina or pores may be detected. As the mouth approaches towards maturity, the grooves are more or less filled up, and the walls thicken, a row of very minute tubercles being discoverable along the crest. At this stage the inner side of the tube ceases to be vertical, being lined by a very narrow inclined band. The mature mouths are separated by a bold ridge, generally simple, but not infrequently

[1] Well shown in a figure by Prof. H. A. Nicholson and the Writer, Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 10.

[2] This term is employed to denote that part of the calice cut off by the diaphragm, or, as it was termed by Lonsdale, the "band."

[3] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 2*a*–2*d*. See also Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 11 & 12

divided by a groove; the double as well as the single ridge being surmounted by a row of prominent tubercles almost in contact with each other. Only one example of the filling up of the mouths has been observed, but it affords satisfactory evidence of a gradual expansion of the inner band, before alluded to, and a final meeting in the centre."

Tabulæ are very sparsely developed, and are often not recognisable at all, but when present are undoubtedly complete. In Pl. VII, Fig. 9, two are visible just previous to the deflection of the tubes towards the periphery. By Prof. Nicholson and the Writer, the imperfect diaphragm of the vestibule was spoken of as a perforate tabula,[1] but lacking evidence as to the existence of true perforated tabulæ as they exist in *Stenopora (Tabulipora) Howsei*, Nich., it will be better, in the meantime, to refer to this structure as a perforated diaphragm only, without intending to convey by this term the homologue of a true tabula.

In our New South Wales rocks it seems to be particularly difficult to obtain specimens exhibiting the surface. This arises, possibly, from the tenacious manner in which the numerous prickle-like acanthopores adhere to the matrix. On the other hand, in Tasmanian examples the surface characters are usually well displayed, for the deposits in that island, characterised by *Stenopora*, appear to be more calcareous than do our Marine beds, and better adapted for the weathering-out of fossils. In *S. tasmaniensis* the acanthopores are very numerous, often forming a complete ring round the mouth of the calice,[2] as many as twelve having been counted in this position, on the somewhat angular interstitial surfaces. Or the acanthopores may be placed in more or less longitudinal oblique rows, similar to the calices, when the circular arrangement becomes gradually lost. When such is the case a depressed surface exists on the interstitial surface of the corallum, between contiguous rows of calices, giving rise to the appearance of a groove, as shown in another of Lonsdale's figures.[3]

The distinguishing points relied on for specific determination in *S. tasmaniensis* are:—1. The irregularity in the diameter of the branches, and its lesser size when compared with that of *S. ovata*. This is, perhaps, not a very stable character, as some specimens of *S. tasmaniensis* attain a fair development, but I think it may be accepted that, as a rule, it is smaller

[1] See Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 12.
[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 2 *a-c*.
[3] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 2*d*.

than *S. ovata*. 2. The character of the acanthopores just described. 3. The narrow peripheral, and wide axial portions of the corallum. 4. The confluent moniliform expansions of the corallite walls. 5. The calice mouths sometimes partially closed by perforated diaphragms.

With regard to the synonomy, only two points need be touched upon. The figures given by Prof. H. A. Nicholson, in his "Tabulate Corals of the Palæozoic Period,"[1] under the name of *Stenopora tasmaniensis*, do not represent that species, but, as pointed out subsequently,[2] are referable to *Stenopora ovata*, Lonsd. I think it is possible that *S. gracilis*, Dana, sp., may be referable here. The long non-constricted corallites represented in Dana's Fig. 10*a* correspond better with those of this species than they do with those of any other; whilst the illustration of the corallite mouths, in his Fig. 10*b*, have a certain resemblance to some states of those of *S. tasmaniensis*, when the acanthopores are not visible.

Locality[3] *and Horizon.*—Summit of Harper's Hill, near West Maitland, Co. Northumberland (*C. Cullen*); Railway Cutting, Harper's Hill, ditto, (*C. Cullen*) :—Lower Marine Series; Gerringong, near Kiama, Co. Camden (*C. Cullen*) :—Upper Marine Series.

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[1] P. 281, f. 3, A & B.

[2] Ann. Mag. Nat. Hist., 1886, XVII, p. 175, *note*.

[3] Prof. M'Coy mentioned Darlington as a locality for *S. tasmaniensis*, in sandstone (Ann. Mag. Nat. Hist., 1847, XX, p. 226); Dana recorded it from a typical locality, Harper's Hill, near West Maitland (Wilkes' U. S. Explor. Exped., Vol. X, Geology, p. 711).

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EXPLANATION OF THE PLATES.

NOTE.—Unless otherwise stated, the figures are of the natural size.

PLATE I.

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Trachypora Wilkinsoni, Eth. fil. 26

Fig. 1. Portion of a branch showing the distribution of the corallites, and a central abortive branch, x 1½.

Fig. 2. Portion of another branch, in which the septal ridges are better defined, x 1½.

Fig. 3. Small part of a corallum on which the calices open in a contrary direction from opposite ends, x 1½.

Fig. 4. Bifurcating corallum, naturally fractured, showing the corallites in section in the centre of the branches, with tabulæ *in situ*; the calice mouths around the periphery separated by the highly-thickened walls, x 2.

Fig. 5. Small part of Fig. 4 enlarged four times to show these characters more distinctly, x 4.

Fig. 6. Another stem naturally fractured, x 2.

Fig. 7. A stem partially split with the stellate calices admirably shown at the base, x 2½

Fig. 8. Portion of a corallum, from which the whole of the calcareous matter has been dissolved, leaving the fluted internal casts of the corallites as inverted cones, connected by cross-bars which are the inorganic infilling of the pores of communication, magnified.

Figs. 1–6, from Mulbring.
7, „ Shoalhaven.
8, „ Boorook.

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PLATE II.

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Stenopora crinita, Lonsdale... 49

Figs. 1 and 2. Portions of a fine hemispherical mass, exhibiting the long prismatic corallites radiating from an imaginary axis, and the concentric layers of tubes representing periodical stages of growth.

Wollongong.

1

2

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PLATE III.

Page.

Stenopora crinita, Lonsdale... 49

Fig. 1. Base of a circular corallum showing the gradual superimposition of the various colonies composing it, from the original attached to one of the Aviculopectinidæ, probably *Streblopteria*.

Fig. 2. Hemispherical example, fractured, adherent to an organism, now partially removed, probably a univalve.

Fig. 3. Portion of a fractured lobate specimen.

Figs. 4 and 5. Series of tubes taken from different specimens, showing the stratified condition of the corallum generally, the distant moniliform constrictions, and crenulated surface, x 6 and 7 respectively.

Fig. 6. Weathered surface of a lobate fractured example, showing the various degrees of closure of the corallites by the secondary deposition of sclerenchyma, x 12.

Wollongong,

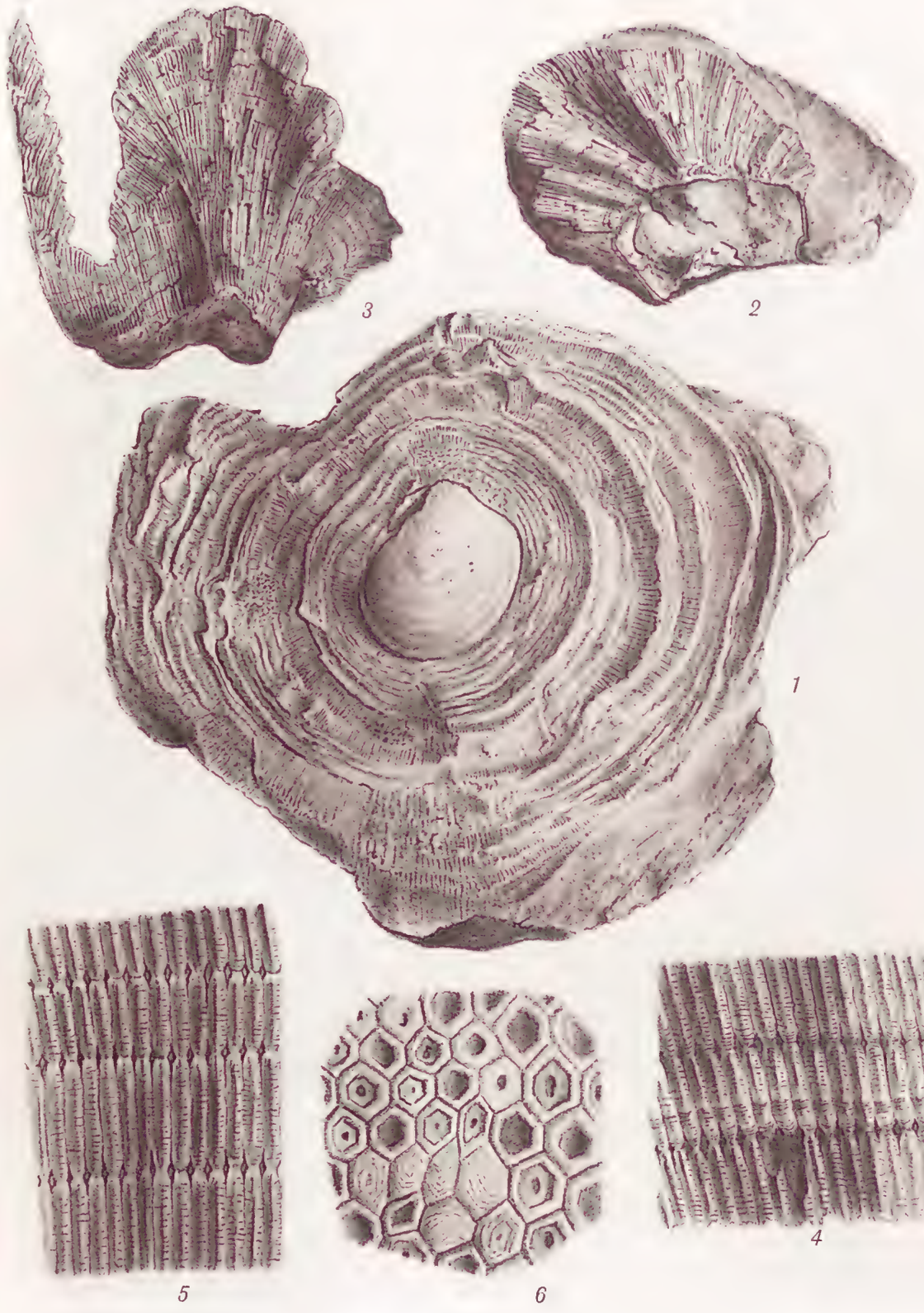

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PLATE IV.

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Fig. 1. *Michelinia*, sp. ind. (? *M. tenuisepta*, Phillips). Polished surface of a small example, cut rather obliquely, showing pores and vesicular tabulæ, x. 2. Carrol, near Somerton 28

Fig. 2. *Stenopora crinita*, Lonsdale. Portion of a highly lobate example. Singleton ... 49

Fig. 3. *Stenopora tasmaniensis*, Lonsdale. Part of a small corallum, showing calices and acanthopores, x. 1½. Harper's Hill 60

Fig. 4. A small part of the surface of Fig. 3, showing the oval form and quincuncial arrangement of the calices, and great development of acanthopores, x. 8.

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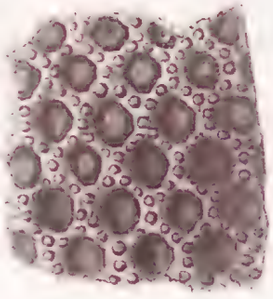

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PLATE V.

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Stenopora crinita, Lonsdale 49

Fig. 1. A small portion of the surface of the specimen figured Pl. II, Fig. 2, with monticules, x. $\frac{1}{2}$.

Fig. 2. Parts of six corallites to show the interpolation of a new tube (This figure should be reversed), x. 4.

Fig. 3. Corallites naturally fractured, seen from the inside, to show moniliform constrictions, and partially filled-up mouths in a lower colony, x. 4.

Fig. 4. Three corallites from a weathered naturally-fractured surface, x 4.

Stenopora ovata, Lonsdale 55

Fig. 5. Part of a branched corallum, giving general features, with peripheral moniliform constrictions.

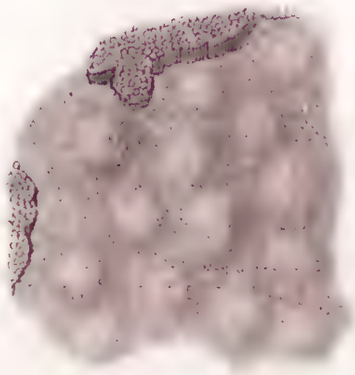
Fig. 6. Portion of Fig. 5 to show these features more distinctly, x. 3

Stenopora tasmaniensis, Lonsdale 60

Fig. 7. Portion of a corallum, with method of branching, &c., fractured and weathered.

Fig. 8. Part of the surface of Fig. 7, x. 3.

Figs. 1, 4, from Wollongong.
2, 3, 5, 6, „ Singleton.
7, 8, „ Gerringong.



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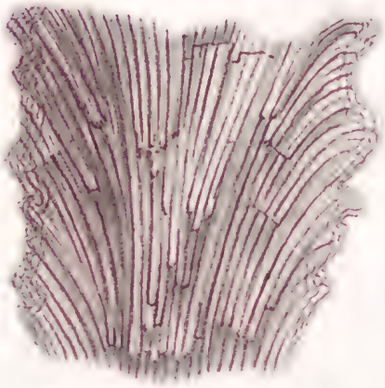

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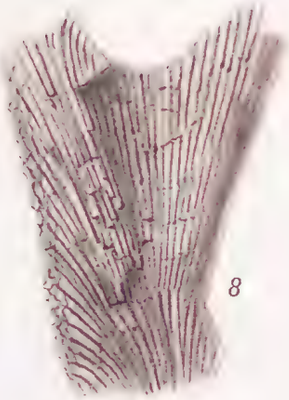

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PLATE VI.

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Trachypora Wilkinsoni, Eth. fil. 26

Fig. 1. Vertical microscopic section showing the dense secondary peripheral deposit, the axial filled-up corallites, with portions of their median lines left open, and crossed by tabulæ, x. 4.

Fig. 2. Similar horizontal section with the sclerenchyma of the axial corallites well marked, leaving in most cases a small central space; and the peripheral corallites gradually bending over to their more or less horizontal position, as evinced by their oblique section, with great thickening of their walls, x. 4.

Stenopora crinita, Lonsdale 49

Fig. 3. Horizontal microscopic section, exhibiting the polygonal corallites, with alternate light and dark concentric rings of secondary sclerenchyma, developed in a greater or less degree, x. 7.

Fig. 4. Similar section, exhibiting the primordial wall, lining of secondary deposit, and acanthopores at the corallite angles, x. 15.

Fig. 5. Another section, showing the fibro-concentric structure of the partially-thickened walls and the triangular young corallites at the calice angles, x. 50.

Fig. 6. Vertical microscopic section of a few tubes exhibiting a line of moniliform constrictions and the long expanse of simple tubes without tabulæ, x. 8, x. 8.

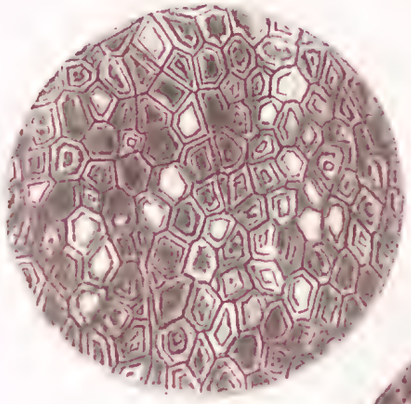
Stenopora ovata, Lonsdale 55

Fig. 7. Vertical peripheral microscopic section exhibiting tabulæ and the walls partially thickened, x. 9.

Fig. 8. Vertical microscopic section from immediately below the surface showing the peculiar form assumed by the moniliform swellings of this species, x. 12.

Figs. 1, 2, from Mulbring.
3, 7, 8, „ Singleton.
4, 5, 6, „ Wollongong.

N.B.—The enlargements are approximate.



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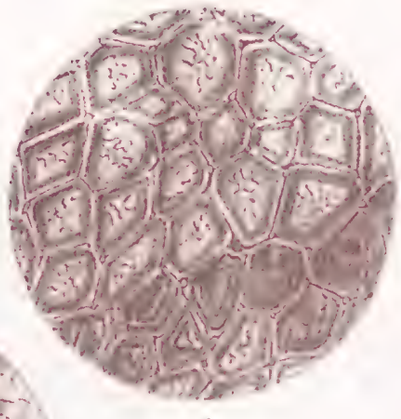

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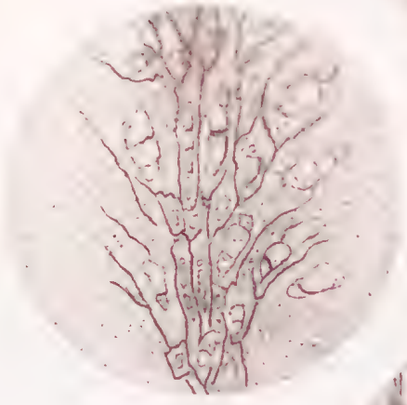

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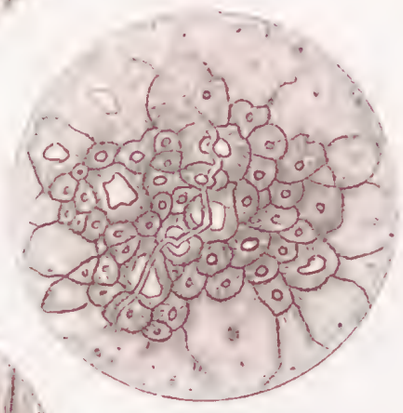

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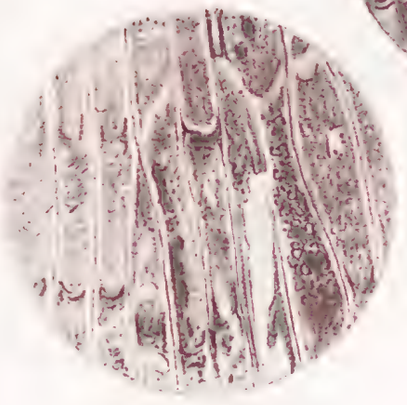

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PLATE VII.

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Stenopora crinita, Lonsdale 49

Fig. 1. Vertical peripheral section to show the elongated tear-shaped moniliform constrictions and tabulæ, x. 16.

Stenopora crinita, Lonsdale? 49

Fig. 2. Axial horizontal section, with thickened and unthickened primordial walls. Acanthopores highly developed, with the concentric structure of their walls apparent, and each with a central clear spot, x. 15.

Stenopora ovata, Lonsdale 55

Fig. 3. Horizontal section, with thickened and unthickened walls. In the former are visible the primordial wall, structure of the secondary thickening, and young corallites at certain angles of the calices, x. 20.

Fig. 4. Tangential section with the whole of the walls thickened; the acanthopores highly and irregularly developed, and the centre of each occupied by a dark spot; corallites very irregularly oval, x. 20.

Fig. 5. Longitudinal section of peripheral region to show the peculiarly crowded and exceedingly moniliform condition of the constrictions and their concentrically fibrous structure, x. 25.

Fig. 6. Longitudinal peripheral section in which the sclerenchyma has been dissolved from the monilæ, leaving them as hollow shells, x. 15.

Frondescent *Stenopora* 59

Fig. 7. Tangential section, showing enormously-thickened walls and copious development of acanthopores, x. 15.

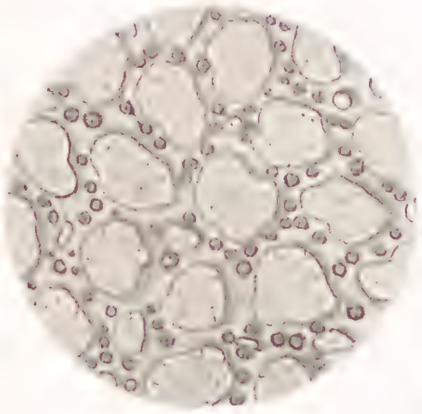
Stenopora Leichhardti, N. & E. 58

Fig. 8. Slightly oblique section of the peripheral region to show the tube-like character of the acanthopores and the generally-thickened walls, x 20.

Stenopora tasmaniensis, Lonsdale 60

Fig. 9. Vertical section partly axial, partly peripheral, showing monilæ, a tabulum, and the inner margin of the greatly-thickened periphery, x. 10.

Figs. 1 and 3 from Singleton.
2, 4–7 „ Tasmania.
8 „ Bowen River Coal-field, Queensland.
9 „ Jerringong.



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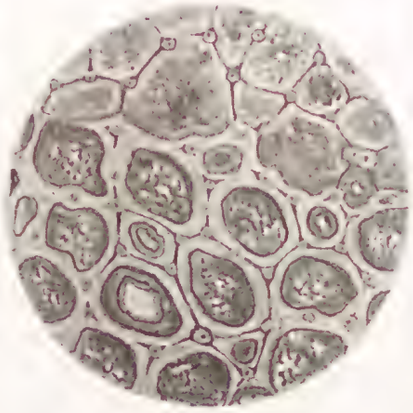

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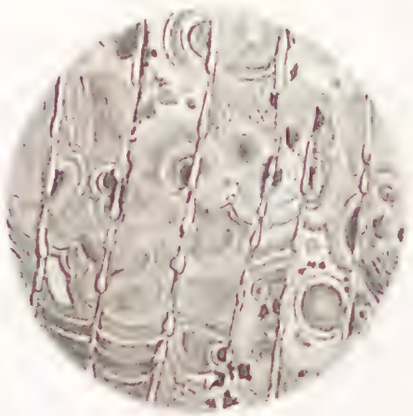

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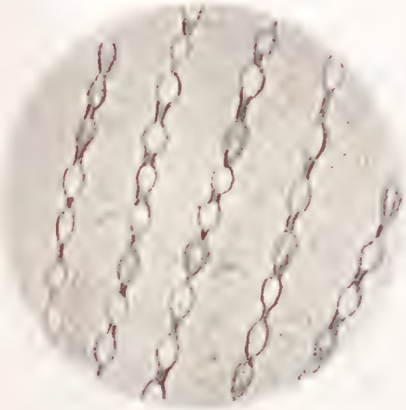

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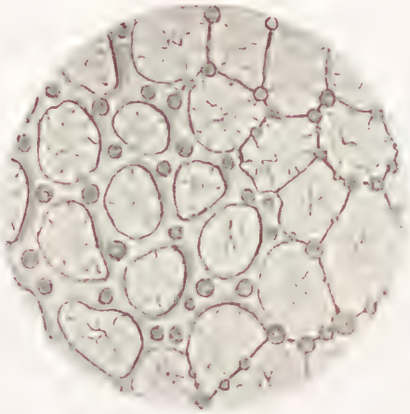

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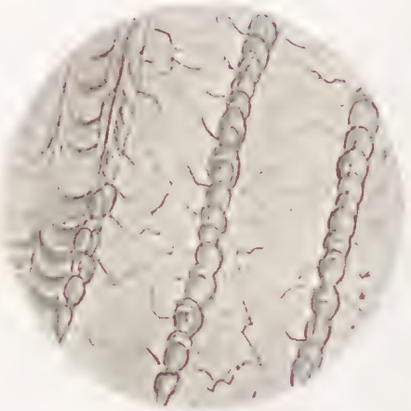

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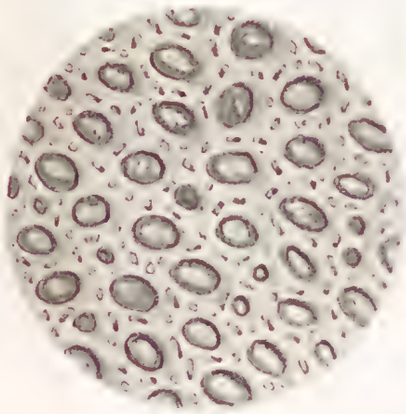

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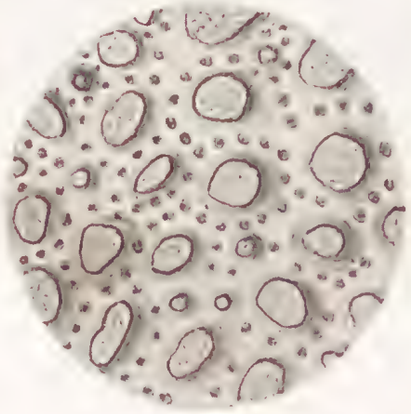

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PLATE VIII.

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Zaphrentis arundinaceus, Lonsdale, sp. 9

Fig. 1. Naturally-fractured section of the corallum, immediately below the calice, showing septa, fossula, and small tabulate area, x $\frac{1}{2}$.

Fig. 2. Opposite end of the same specimen, at a depth of three-quarters of an inch, showing the under-surface of a tabula with the fossula and septa faintly marked at the margin, x $\frac{1}{2}$.

Zaphrentis gregoriana, De Koninck 11

Fig. 3. Corallum seen from the ventral side.

Fig. 4. „ seen laterally.

Fig. 5. „ of a more robust variety, seen laterally.

Fig. 6. „ „ „ seen ventrally.

Fig. 7. Vertical section of a corallum, showing the base of the calice composed of large vesicles, and an upwardly-directed process of the floor.

Fig. 8. Naturally-fractured transverse section, with a large fossula and central tabulate area, x $\frac{1}{2}$.

Fig. 9. Transverse section, showing septa, scattered dissepiments, and vesicular base of calice, x 2.

Fig. 10. Portions of five septa, highly enlarged, to show the flexuous primordial septum in each.

Fig. 11. Naturally-weathered calice, x $\frac{1}{2}$.

Fig. 12. Naturally-weathered transverse section, in which the whole of the loculi have become filled with stereoplasma, x $\frac{1}{2}$.

Zaphrentis cainodon, De Koninck... 10

Fig. 13. A weathered corallum, side view.

Fig. 14. Calice and part of corallum, ventral view, showing septa and fossula, x $\frac{1}{2}$.

Fig. 15. Transverse section, showing septa and vesicular base of calice, x 2.

Fig. 16. Vertical section, showing vesicular base of calice.

Figs. 1–16 from Shoalhaven District.

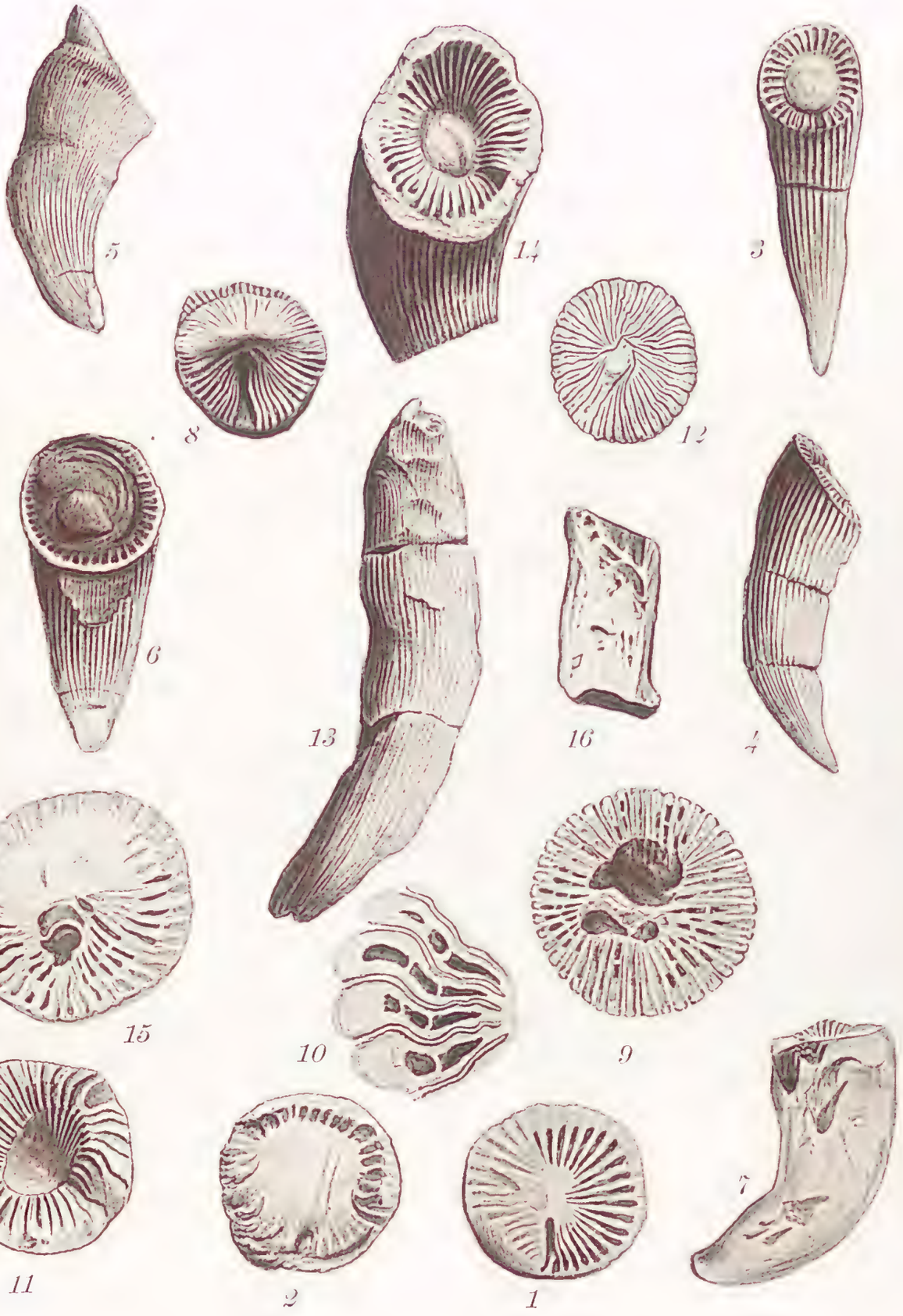
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PLATE IX.

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Zaphrentis Culleni, Eth. fil. 13

Fig. 1. A much-curved corallum, showing the slight accretion swellings, x $\frac{1}{2}$.

Fig. 2. A less-curved corallum.

Fig. 3. A much-curved corallum, with constricted base and delicate rugæ, x $\frac{1}{2}$.

Fig. 4. A small cornute example, but little curved, x 2.

Fig. 5. Transverse section below the calice entirely filled with stereoplasma, x 3.

Fig. 6. Another section in which the loculi are partly filled only, x 3.

Fig. 7. Section with the calice, with primary and secondary septa, x 3.

Zaphrentis gregoriana, De Koninck (?) 11

Fig. 8. An internal cast of a corallum with impressions of the epithecal spines on the adjoining matrix, x 2.

Fig. 9. Impression of the exterior of a corallum, with the imprints of the epithecal spines.

Amplexus, sp. ind.... 7

Fig. 10. Cast of a portion of a corallum, from which the whole of the calcareous matter has been removed, showing the position of tabulæ, x 2.

Zaphrentis, arundinaceus, Lonsdale, sp. 9

Fig. 11. Calice, naturally weathered, x $\frac{1}{2}$.

Fig. 12. Lower fractured end of the same specimen at one and a quarter inches, to show similar characters to Pl. VIII, Fig. 2, x $\frac{1}{2}$.

Fig. 13. A reversed corallum, to show the irregular vesicular tabulæ.

Zaphrentis phymatodes, Eth. fil. 15

Fig. 14. Side view of corallum, with obtuse tubercles.

Fig. 15. A few of the tubercles seen on Fig. 14 highly magnified. (N.B.—The stellate appearance is too highly intensified.)

Fig. 16. The upper part of the corallum, with the septa gathering towards the centre, and the loculi partially filled, x $\frac{1}{2}$.

Fig. 17. The lower portion of the same, with the loculi further filled with stereoplasma, x $\frac{1}{2}$.

Campophyllum columnare, Eth. fil. ... ...

Fig. 18. Corallum, side view.

Fig. 19. Transverse section, showing tabulæ, dissepiments, and central tabulate area, with rather vesicular tabulæ, x $\frac{1}{2}$.

Fig. 20. Transverse section, with a large tabulate area, x $\frac{1}{2}$.

Figs. 1– 7, 18–20, from Binge Berry, Rouchel Brook.
8–13, „ Shoalhaven District.
14–17, „ Mulbring.

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PLATE X.

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Zaphrentis robusta, De Koninck 14

Fig. 1. An almost complete corallum seen from the side, x $\frac{1}{2}$.

Fig. 2. Base of Fig. 1, showing cardinal, counter, and alar septa, x 2.

Fig. 3. Calice margin with septa, x $\frac{1}{3}$.

Cyathophyllum? zaphrentoides, Eth. fil. 21

Fig. 4. Parent corallum, side view, with a young corallite springing from the calice.

Fig. 5. Transverse section of the lower part of the corallum, x $\frac{1}{2}$.

Fig. 6. Transverse section of the upper half of the same, x $\frac{1}{2}$.

Lophophyllum corniculum, De Koninck 18

Fig. 7. Corallum, side view, x $\frac{1}{2}$.

Fig. 8. Transverse section of the calice towards its base, with septa, a few dissepiments, and the spurious columella, x 2.

Fig. 9. Similar section taken at a lower level, x 2.

Aulophyllum Davidis, Eth. fil., *Var.* 23

Fig. 10. Corallum, side view, showing irregular growth.

Fig. 11. Portion of a vertical section, with the three subdivisions of the corallum—outer, or interseptal space; intermediate, or interlocular space; and interlamellar, or central area, x $\frac{1}{2}$.

Fig. 12. Transverse section with similar features, x $\frac{1}{2}$.

Cyathophyllum retiforme, Eth. fil. 22

Fig. 13. Transverse section below the calice, x $\frac{1}{3}$.

Fig. 14. „ „ at a rather higher level, x $\frac{1}{3}$.

Fig. 15. A few septa, highly enlarged, to show the peculiar dissepiments between the primary and secondary septa.

Figs. 1–3, from Branxton.
4–6, 10–15, „ Binge Berry, Rouchel Brook.
7–9, „ Dungog Road.

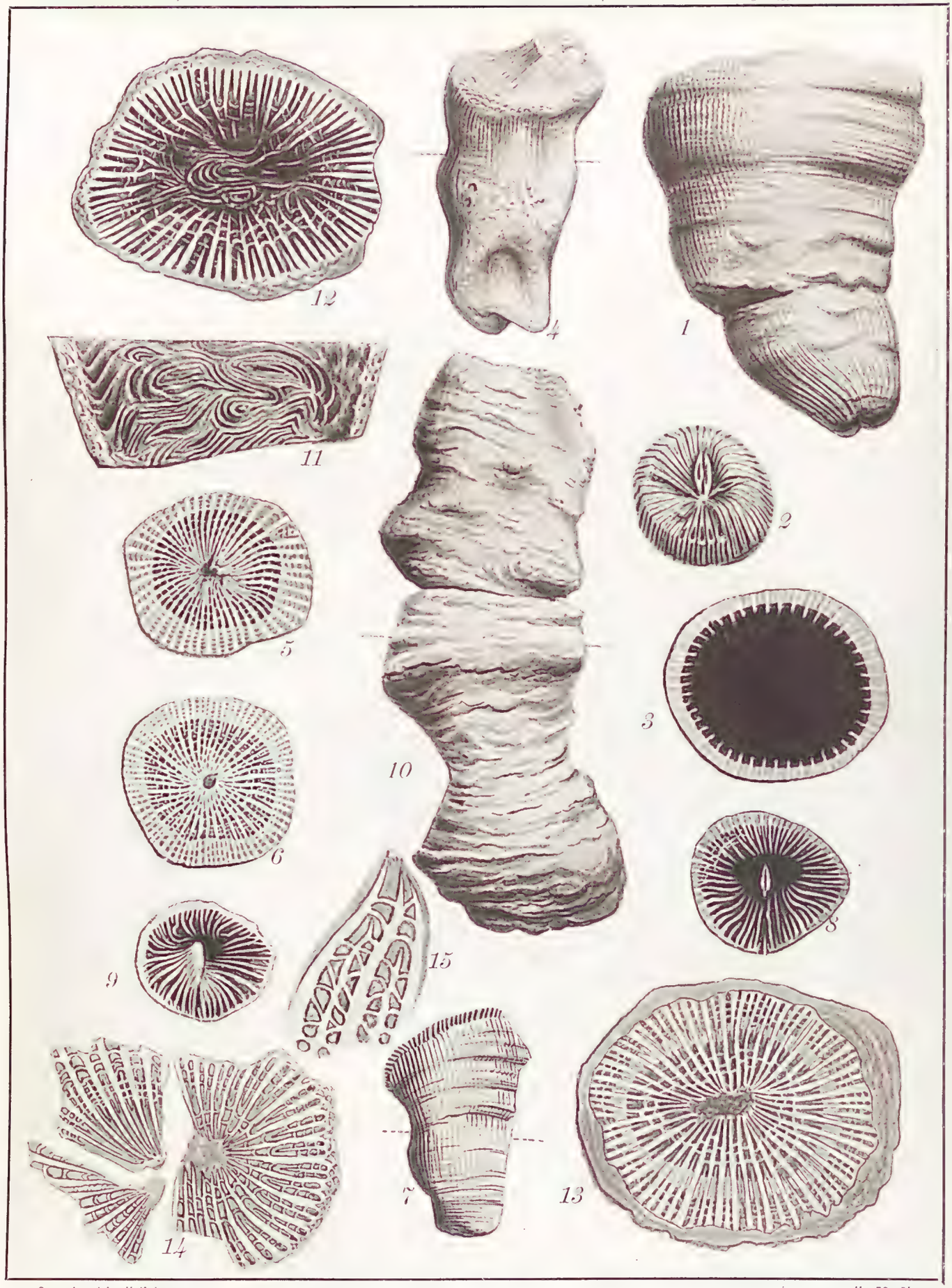
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PLATE XI.

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Aulophyllum Davidis, Eth. fil. 23

Fig. 1. Corallum, side view.

Fig. 2. Transverse section, showing the three areas of subdivision, x $\frac{1}{2}$.

Fig. 3. Portion of longitudinal or vertical section.

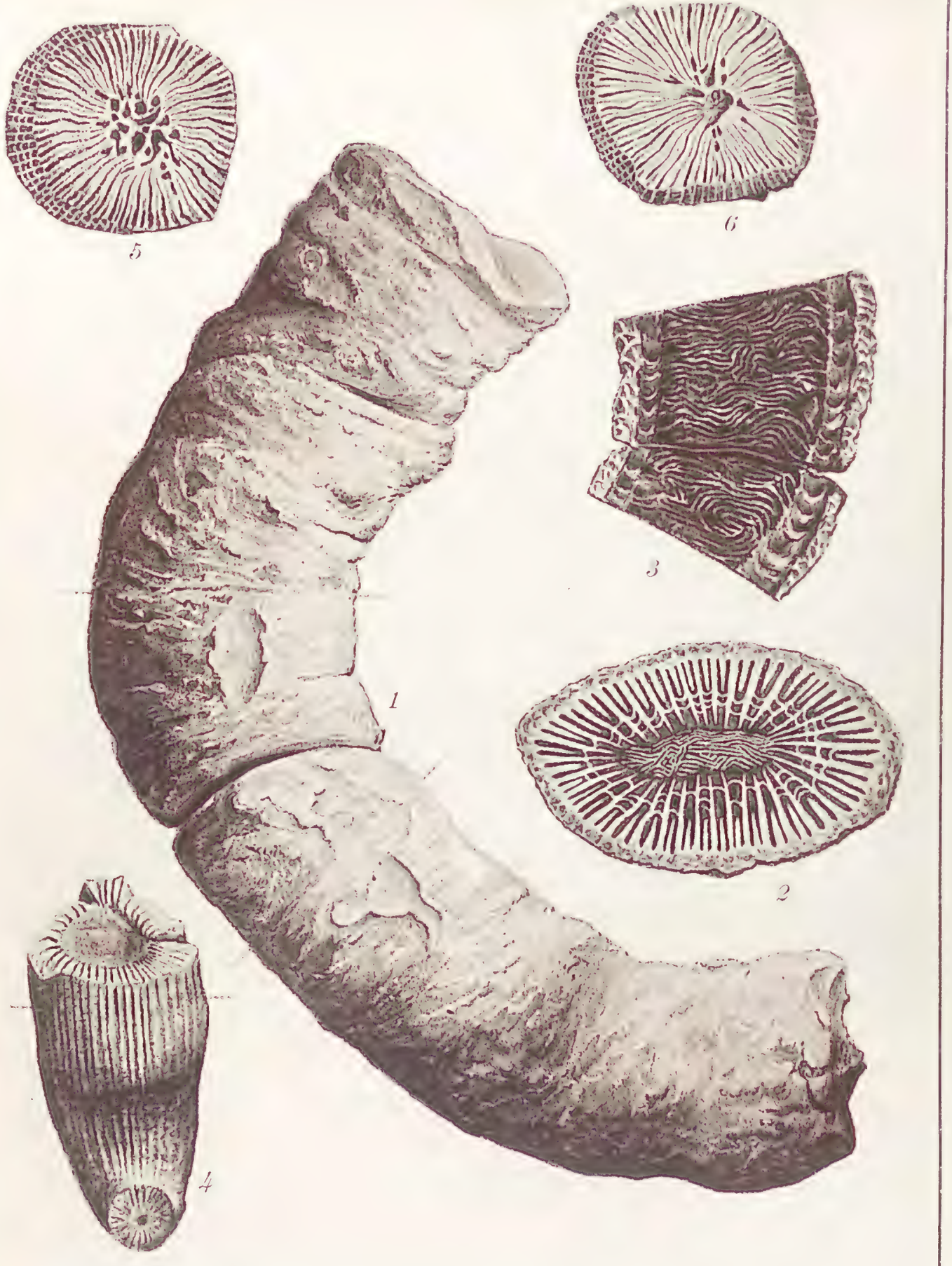
Zaphrentis ? sumphuens, Eth. fil. 16

Fig. 4. Corallum, ventral view, x $\frac{1}{2}$.

Fig. 5. Transverse section immediately below the calice, x 2.

Fig. 6. Transverse section at a lower level still, x 2.

Figs. 1–3, from Binge Berry, Rouchel Brook.
4–6, „ Somerton.



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